...ineering
...rary
AUG 12 1924
PRINTED ON THIN PAPER FOR FOREIGN CIRCULATION.

ENGINEERING:

An Illustrated Weekly Journal.

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C. 2.

VOL. CXVIII.—No. 3057.] *LONDON: FRIDAY, AUGUST 1, 1924.* [*Registered at the General Post Office as a Newspaper.*] [PRICE ... 1s. BY FOREIGN POST 1s. 4d.

Aveling & Porter, Ltd.,
ROCHESTER.
1869
Steam Road Rollers & Tractors.

A. G. Mumford, Ltd.,
CULVER STREET WORKS, COLCHESTER.
ON ADMIRALTY AND WAR OFFICE LISTS.
ENGINES for Torpedo Boats, Yachts, Launches. BOILER FEED PUMPS.
See Advertisement page 36.
PATENT WATER-TUBE BOILERS. AUTOMATIC FEED REGULATORS.
And Auxiliary Machinery as supplied to the Admiralty. 2179

E. J. Davis, M.I.Mech.E., Gas Engines Inspected, Tested and Reported upon. Over 25 years' experience. Tel.: Maryland 1736 & 1737. Wire: "Rapidising London."—Great Eastern Road, Stratford, E. 15. 1794

Penningtons, University TUTORS, 254, Oxford Road, Manchester. Estab. 1876. Enrol now for I.C.E. and I.M.E. Postal Courses. 100 per cent. passes last Exams. Reinforced Concrete—a new comprehensive course under expert engineer, £3 3s. Write for particulars. 1711

See's Patent Hydro-Pneumatic **Ash Ejector**
Great saving of labour. No noise. No dust. No dirt. Ashes discharged 20 ft. clear of vessel.—Apply, F. J. TREWENT & PROCTOR, LTD., Naval Architects and Surveyors, 43, Billiter Bldgs., Billiter St., London, E.C. Od 4835

THE GLASGOW ROLLING STOCK AND PLANT WORKS.
Hurst, Nelson & Co., Ltd.,
Builders of RAILWAY CARRIAGES, WAGONS ELECTRIC CARS, and EVERY OTHER DESCRIPTION OF RAILWAY and TRAMWAY ROLLING STOCK. Makers of WHEELS and AXLES, RAILWAY PLANT, FORGINGS, SMITH WORK, IRON & BRASS CASTINGS. PRESSED STEEL WORK OF ALL KINDS. Od 3382
Reg. Office and Chief Works: Motherwell. London Office: 32, Great St. Helen's, Bishopsgate, E.C. 3.

Tank Locomotives.
Specification and Workmanship equal to Main Line Locomotives.
R. & W. HAWTHORN, LESLIE & CO. LTD., ENGINEERS, NEWCASTLE-ON-TYNE. 1864

Spencer-Hopwood & Kirke PATENT BOILERS. *See page 43, July 25.* 1994
Sole Makers: SPENCER BONECOURT, LTD., Parliament Mansions, Victoria St., London, S.W.

The Glasgow Railway Engineering Company, GOVAN, GLASGOW. LTD.,
London Office—12, Victoria Street, S.W.
MANUFACTURERS OF RAILWAY CARRIAGE, WAGON & TRAMWAY WHEELS & AXLES, CARRIAGE & WAGON IRONWORK, also CAST-STEEL AXLE BOXES. 1948

Forgings & Stampings.
FELLOWS BROS., LTD., CRADLEY HEATH, STAFFS. 9158

Steam Hammers (with or without guides). Hand-worked or self-acting TOOLS for SHIPBUILDERS & BOILERMAKERS.
DAVIS & PRIMROSE, LIMITED, LEITH, EDINBURGH. 1914

Bever, Dorling & Co., Ltd.,
BRADFORD.
HIGH-CLASS ENGINES FOR ALL PURPOSES, also WINDING, HAULING, AIR COMPRESSING and PUMPING ENGINES 1896

GOLD MEDAL-INVENTIONS EXHIBITION-AWARDED
Duckham's Patent Suspended WEIGHING MACHINES—EAST FERRY ROAD ENGINEERING WORKS COMPANY, LTD. London, E.—Hydraulic Cranes, Grain Elevators, &c.
See illus. Advt. last week, page 15. 1715

CRANES. All Types.
GEORGE RUSSELL & CO., LTD., Motherwell. 1867
Telegrams:—"Cylinders," Birmingham.

Weldless-Steel Tubes for Water-tube Boilers, Superheaters, Hustling, Hydraulic Work, Boring Rods, &c.
TUBES LIMITED, BIRMINGHAM. 08179

YARROW & CO. (1922), LTD., GLASGOW.
PASSENGER AND CARGO STEAMERS.
SHALLOW DRAFT VESSELS. 2276

Campbells & Hunter, Ltd.
SPECIALISTS IN
Drillers & Boring Machinery
for Engine Works and Boiler Shops.
DOLPHIN FOUNDRY, LEEDS. 4547

VOSPER & Co., LTD.,
PORTSMOUTH.
SHIP & LAUNCH BUILDERS, Od 3551
ENGINEERS & BOILER MAKERS.

For Your Repairs or any SPECIAL MACHINERY, try THOMAS HUNT & SONS, Albion Ironworks, Bridge Road West, Battersea, S.W. 11. Est. 1854. 2213

The Mitchell Conveyor and TRANSPORTER CO., LTD., CONTRACTING ENGINEERS.
DESIGNERS and BUILDERS of all Classes of HANDLING MACHINERY.
Atlantic House, 45-50, Holborn Viaduct, London, E.C. 1.
Telegrams: "Micontraco, Cent, London." Telephone: Holborn 2622. 1713

Dredging Plant—
For ALLUVIAL GOLD, PLATINUM & TIN, HARBOUR, RIVER & CANAL.—Gravel Dredgers, SCREENS.—DREDGE BUCKETS & Parts, all sizes.
ARTHUR R. BROWN, 84, New Broad Street, London, E.C.2. Telephone: London Wall 3418. 1814

RAILWAY AND TRAMWAY ROLLING STOCK.
Hurst, Nelson & Co., Ltd.,
THE GLASGOW ROLLING STOCK AND PLANT WORKS, MOTHERWELL. Od 3383

P. & W. MacLellan, Ltd.,
CLUTHA WORKS, GLASGOW.
MANUFACTURERS OF RAILWAY CARRIAGES AND WAGONS OF EVERY DESCRIPTION.
RAILWAY IRONWORK, BRIDGES, ROOFING, &c.
Chief Offices: 129, Trongate, Glasgow. Od 3547
Registered Offices: Clutha House, 10, Princes St., Westminster, S.W.1.

Regent Guillotine Shears and Power Presses
FOR SHEET AND PLATE WORKING.
THE REGENT SHEET METAL MACHINE TOOL CO., LTD., REGENT WORKS, WAKEFIELD. 2018

Iron and Steel
Tubes and Fittings.
Sole Licensees in Great Britain for the manufacture of "Armco" Rust and Corrosion Resisting Iron Tubes. 2257
The Scottish Tube Co., Ltd.,
HEAD OFFICE: 34, Robertson Street, Glasgow.
See Advertisements, pages 35 and 89.

Royles Limited,
ENGINEERS, IRLAM, MANCHESTER.
FEED WATER HEATERS, CALORIFIERS, EVAPORATORS, CONDENSERS, AIR HEATERS } Row's Patents.
STEAM and GAS KETTLES, Merrill's Patent TWIN STRAINERS for Pump Suctions.
SYPHONIA STEAM TRAPS, REDUCING VALVES
High-class GUNMETAL STEAM FITTINGS.
WATER SOFTENING and FILTERING. 5723

IRON & STEEL
Tubes AND Fittings AND Steel Plates.
STEWARTS AND LLOYDS, Ltd.
GLASGOW BIRMINGHAM - LONDON.
See Advertisement, page 27. 1872

Cement.—Maxted & Knott, LTD., Consulting Cement Engineers, ADVISE GENERALLY on proposed Cement Schemes FOR ENGLAND AND ABROAD. ADVICE ONLY. Highest References. Established 1890.
Address, BURNETT AVENUE, HULL.
Cablegrams: "Energy, Hull." 1828

Machinery, Plant, &c.

FIVE LANCASHIRE BOILERS, 30 ft. by 7 ft. 6 in., now insured at 150 lbs. pressure.

SEVERAL HUNDREDS OF TANKS, rectangular and circular, ten gallons capacity upwards.

Cheap, to save second removal, Six very good, second-hand, single-ended, three-furnace, MARINE BOILERS, about 13 ft. by 10 ft. long, reinsurable 180 lbs. working pressure.

MULTIPLE SPINDLE DRILLING MACHINE, by Baush Machine Tool Co., 12 spindles ¾ in. diam., bored No. 2 morse taper, low base 2 ft. 9 in. by 2 ft. 6in.

New 3 in. HORIZONTAL BORING, DRILLING AND TAPPING MACHINE, by Dickinson Machine Tool Co., traverse of spindle 24 in., gear-box drive.

12 in. stroke SIDE DRIVEN SLOTTING MACHINE, by J. Archdale & Co., circular table 30 in. dia., 2 ft. 3 in. gap to tool.

28 in. stroke HEAVY DUTY PILLAR TYPE SHAPING MACHINE, by Columbia Machine Tool Co., T-slotted table 18 in. by 28 in. by 18 in. deep.

About 192 feet of GANTRY, comprised of 14 in. by 6 in. joists, each 34 ft. long, and seven Stancheons about 13 ft. 10 in. long of 8 in. by 6 in. section. Nearly new in condition, and ready for despatch.

Overhead three-motor Electric TRAVELLING CRANES, suitable for 440 volt. continuous current.

One 5-ton, 37 ft. 6 in. span.

One 2-ton, 20 ft. 0 in. span.

Also 1-ton Electric Travelling UNDERHUNG JIB CRANE, span 29 ft. 7½ in., 480 volts.

Thos. W. Ward, Ltd.,
ALBION WORKS, SHEFFIELD. 1726
Palace of Engineering, Wembley, Stand 189. Bay 23-24. Avenue 1-2.

Important.—For Immediate SALE AT LOW PRICES.
One Superior 400 Kw. Howden - Siemens ELECTRIC GENERATING SET, 250 volts D.C., 350 r.p.m., 155 lbs. pressure.
One High-Class Horizontal Side - by - Side COMPOUND CORLISS ENGINE, 200 I.HP., at 80 r.p.m., belt flywheel 12 ft. diameter by 2 ft. 6½ in. on face, very suitable for export, for driving factory, sawmill, etc.
One Powerful Set COMPOUND HORIZONTAL HYDRAULIC PUMPING ENGINES, by Sir Wm. Arrol & Co., capacity 300 gallons per minute.
Two Steamdriven CENTRIFUGAL PUMPS, by Drysdale, capacity 1250 and 1200 gallons per minute.
In new condition and all seen here at Glasgow.
JOHN H. RIDDELL LTD., 40, St. Enoch Square, Glasgow. 2101

YARROW & CO. (1922), LTD., GLASGOW.
LAND AND MARINE
YARROW BOILERS. 2277

John Bellamy Limited,
MILLWALL, LONDON, E.
GENERAL CONSTRUCTIONAL ENGINEERS. 1216
Boilers, Tanks & Mooring Buoys
STILLS, PETROL TANKS, AIR RECEIVERS, STEEL CHIMNEYS, RIVETTED STEAM and VENTILATING PIPES, HOPPERS, SPECIAL WORK, REPAIRS OF ALL KINDS.

Head, Wrightson & Co., LIMITED.
See Advertisement page 62, July 25. 2402

Matthew Paul & Co., Ltd. LEVENFORD WORKS, **Dumbarton.** 2112
See Full Page Advt., page 62, July 18.

Taylor & Challen Presses
For Production of SHEET METAL WORK, COINAGE, CARTRIDGES AND GUNPOWDER. Foundry, Works and Showrooms: BIRMINGHAM.
See Advert., page 58, July 18. 8196

Railway Switches and Crossings.
T. SUMMERSON & SONS, LIMITED, DARLINGTON. 2006

ON ADMIRALTY LIST.
John Kirkaldy, Ltd.,
London Office: 101, LEADENHALL ST., E.C.3.
Works: BURNT MILL, near HARLOW, ESSEX.
Makers of
Evaporating and Distilling Plants.
Refrigerating and Ice-making Machinery.
Feed Water Heaters.
Evaporators.
Fresh Water Distillers.
Main Feed Pumps.
Combined Circulating and Air Pumps.
Auxiliary Surface Condensers, &c., &c. 2337

WAYGOOD-OTIS LIFTS 2130
54 & 55, FETTER LANE, LONDON, E.C. 4, 62 & 63, LIONEL STREET, BIRMINGHAM, and Principal Provincial Cities and Abroad.

To Save Weight — and Avoid Rust — Employ Aluminium.
Data from British Aluminium Co., Ltd., 109, Queen Victoria St., London. 2017

The Manchester Steam Users' ASSOCIATION.

For the prevention of Steam Boiler Explosions and for the attainment of Economy in the Application of Steam. 9, MOUNT STREET, MANCHESTER.
Chief Engineer: C. B. STROMEYER, M.I.C.E.
Founded 1854 by Sir WILLIAM FAIRBAIRN.
Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 2005

University of Birmingham.

FACULTY OF SCIENCE.

ENGINEERING DEPARTMENTS.

I.—MECHANICAL ENGINEERING.
Chance Professor: F. W. BURSTALL, M.Sc., M.A. (Cantab.), M.Inst.C.E. M.Inst.M.E.
Lecturer: R. C. PORTER, M.Sc. (Vict.), A.M.Inst.C.E.
Demonstrator: S. J. ELLIS, B.Sc., A.M.I.C.E.
Lecturer on Machine Design: F. H. BODEN, B.Sc.
Assistant Lecturer on Machine Design: H. P. DEAN, B.Sc.
II.—CIVIL ENGINEERING.
Beale Professor: CYRIL BATHO, D.Sc., B.Eng.
Lecturers: R. C. PANTON, M.Sc.
H. W. COULTAS, M.Sc.
T. H. P. VEAL, B.Sc.
Lecturer on Town Planning: W. HAYWOOD.
III.—ELECTRICAL ENGINEERING.
Professor: WILLIAM CRAMP, D.Sc.
Lecturer: E. J. KIPPS, M.Sc., M.Inst.E.E.
Assistant Lecturers and Demonstrators: O. R. RANDALL, M.Sc.
G. M. HARVEY, M.Sc., B.Eng.

The FULL COURSES EXTEND OVER FOUR YEARS, and students who enter after matriculation and pass sucessfully the examinations at the end of each year will BE ENTITLED TO THE DEGREE OF BACHELOR OF SCIENCE in Engineering.
THE SESSION 1924-25 COMMENCES ON OCTOBER 6th, 1924.
For detailed syllabus of the Faculty with full particulars of University Regulations, Lecture and Laboratory Courses, Fees, etc., apply to the REGISTRAR. F 444

University College of Swansea.

(A Constituent College of the University of Wales).

APPLIED SCIENCE DEPARTMENTS.

ENGINEERING.
Professor: FREDERIC BACON, M.A. (Cantab.), A.M.Inst.C.E., M.I.Mech.E., M.I.E.E.
Lecturer in Electrical Engineering: R. G. ISAACS, M.Sc. (Bristol), B.Sc. (Lond.), A.M.I.E.E.
Lecturer in Civil Engineering: H. H. BURNESS, M.C., B.Sc. (St. Andrews), A.M.Inst.C.E., A.M.I.Mech.E.
Assistant Lecturer: J. SELWYN CASWELL.
METALLURGY.
Professor: C. A. EDWARDS, D.Sc. (Manchester).
Lecturer: A. L. NORBURY, M.Sc. (Manchester).
Assistant Lecturers: L. B. PFEIL, B.Sc. (Lond.), A.R.S.M., P. M. MACNAIR, B.Sc. (Glasgow).

The College offers a number of exceptional advantages to Students who aim at entering upon professional careers in Engineering or in Metallurgy. It is situated in the heart of an industrial area, which includes a large number of works of very varied character, and presents an unrivalled variety of metallurgical practice. The manufacturers of the district who contribute largely to the support of the College, give the Staff and Students of the Applied Science Departments every access to the Works, and the Managers, Engineers, and Technical Officials co-operate with the Staff of the College in making visits to works of practical educational value to the students.

Courses of study are provided (1) for the B.Sc. degree of the University of Wales in (a) Civil Engineering; (b) Mechanical Engineering; (c) Electrical Engineering; (4) Metallurgy, and (5) for Diplomas of the College in (a) Civil Engineering; (b) Mechanical Engineering; (c) Electrical Engineering; (d) Metallurgy.

Persons who are not desirous of studying for Degrees or Diplomas may attend selected College Classes, provided they satisfy the authorities of the College that they are qualified to benefit by such classes.

Entrance Scholarships will be offered for competition in September, 1924.

Particulars concerning admission to the College, and of the Entrance Scholarships, may be obtained from the undersigned.

EDWIN DREW,
Registrar.
Singleton Park, Swansea. F 263

Correspondence Courses for

Inst.Civil Engrs., Inst.Mech.E., London Univ. (Matric., Inter., B.Sc.), and All ENGINEERING EXAMINATIONS personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours), Assoc.M.Inst.C.E., M.R.S.I., F.R.S.A., etc. Also Day Tuition in Office. Excellent results at all Exams. Courses may commence at any time, and all Students receive individual tuition.—For full particulars apply to S/11, TRAFFORD CHAMBERS, 55, SOUTH JOHN STREET, LIVERPOOL. 1993

Engineering Salesmanship

and SALES MANAGEMENT.—Write for brochure describing our special Course of Training for posts of unlimited scope in this lucrative field.—DIRECTOR, Institute of Engineering Salesmanship, 333, Oxford Road, Manchester. 2283

Engineering Drawing.—

Special Postal Course in Engineering Drawing. Enrol now. Fee Three Guineas for the complete course. Also day tuition in Office by qualified teacher.—PERCY PITMAN, M.I.Mech.E., (nephew of the late Sir Isaac Pitman), 36, Victoria Street, London, S.W.1. 2297

TENDERS.

THE COMMISSIONERS OF HIS MAJESTY'S WORKS, etc., are prepared to receive

Tenders before Eleven

a.m. on Tuesday, 12th August, 1924, for the SUPPLY of MOTOR LAWN MOWERS.

Forms for Tender, etc., may be obtained on application to the CONTROLLER OF SUPPLIES, H.M. Office of Works, etc., King Charles Street, Westminster, London, S.W.1. F 468

STATE ELECTRICITY COMMISSION OF VICTORIA.
Melbourne,
Victoria,
AUSTRALIA.

Tenders are Hereby

Invited for the SUPPLY, DELIVERY, etc., of the following for the Morwell Power Scheme.

Copies of Tender Form and Specification will be available upon application to:—
AGENT-GENERAL FOR VICTORIA,
Melbourne Place, Strand,
London, W.C. 2.

SPECIFICATION No. 24/68—
22,000 VOLT. INSULATORS.

CHARGE:—£2 2s. for the first three copies of Tender Form, Conditions of Contract and Specification complete. This charge will be returned on receipt of a *bona-fide* Tender. A fourth copy, and any further copies, will be supplied for the sum of 10s. 6d. each. This charge is not returnable.

PRELIMINARY DEPOSIT:—A Preliminary Deposit of £100 is to be lodged with Tender.

The Specification may be inspected at the abovementioned office.

The Commission does not bind itself to accept the lowest or any Tender.

Tenders on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than Five p.m., 20th October, 1924.

R. LIDDELOW,
Secretary. F 481

TO ENGINEERS AND OTHERS.

THE RAMSAY CONDENSING LOCOMOTIVE COMPANY, LIMITED.
(In Voluntary Liquidation.)

The Subscriber is prepared to receive

Offers for the Assets of The

Ramsay Condensing Locomotive Company, Limited.

The Assets consist of an experimental Turbo-electric-condensing Locomotive and valuable patents in connection therewith and other patents protecting the Company's inventions and improvements in the matters of Steam Condensation and Condensers.

Full particulars can be obtained on application to the Subscriber.

Offers to be lodged with Subscriber not later than Saturday, 30th August, 1924. Offers made under seal will not be opened before 30th August.

PETER RINTOUL, C.A.,
Liquidator.
105, St. Vincent Street,
GLASGOW, 28th July, 1924. F 466

H.E.H. THE NIZAM'S GUARANTEED STATE RAILWAYS COMPANY, LIMITED.

The Directors of H.E.H. the Nizam's Guaranteed State Railways Company, Limited, are prepared to receive

Tenders for the Supply of:—

(1) 100 OPEN-GOODS WAGONS,
(2) 200 PAIRS of WHEELS and AXLES.

For each copy of the Specification a Fee of Ten shillings will be charged, which is not returnable.

Tenders, enclosed in sealed envelopes, addressed to the Chairman and Directors, and endorsed "Tender for Wagons," or "Tender for Wheels and Axles," as the case may be, must be delivered at the Company's Offices not later than Twelve (Noon), on Friday, 22nd August, 1924.

The Directors do not bind themselves to accept the lowest or any Tender.

F. ADAMS, Secretary.
271, Winchester House,
Old Broad Street,
London, E.C.2.
26th July, 1924. F 459

TYNE IMPROVEMENT COMMISSION.

TEN-TON OVERHEAD ELECTRIC TRAVELLING CRANE AT HOWDON YARD.

The Tyne Improvement Commissioners are prepared to receive

Tenders for the Delivery and

ERECTION of a Ten-ton OVERHEAD ELECTRIC TRAVELLING CRANE at their NEW ERECTING SHOP at HOWDON-on-TYNE.

Specification and General Conditions of Contract may be inspected at the Offices of the Architects, Messrs. CACKETT & BURNS DICK, FF.R.I.B.A., Pilgrim House, Pilgrim Street, Newcastle-upon-Tyne, and manufacturers desirous of Tendering for the work should forward their names and addresses to them not later than 4th August, 1924, together with a deposit of £2 2s., which amount will be returned upon receipt of a *bona fide* Tender.

Tenders in sealed envelopes, endorsed on the cover "Tender for Overhead Electric Travelling Crane," must be addressed to the Chairman, Dredging and River Works Committee, and delivered at the undermentioned Offices not later than Noon on 15th August, 1924.

The Commissioners do not bind themselves to accept the lowest or any Tender.

By Order,
ALBERT BLACKLOCK, Secretary.
Tyne Improvement Commission Offices,
Bewick Street,
Newcastle-upon-Tyne.
21st July, 1924. F 422

THE GREAT INDIAN PENINSULA RAILWAY COMPANY, 48, Copthall Avenue, London, E.C. 2, invite

Tenders for :—

1. RAILWAY TICKETS ... Fee 2s. 6d.

Tenders are due by Eleven a.m. on 12 h August, 1924. Tender forms obtainable at above address. Fees not returnable. F 485

THE COASTGUARDS AND FISHERIES SERVICE of the EGYPTIAN GOVERNMENT are calling for

Tenders for a River Motor

LAUNCH, length 43 feet, beam 7 ft. 9 in., Draft Ext. 2 feet, fitted petrol or petroleum motor. Tenders will be received at the Office of the Coastguards and Fisheries Service, Govenorate Buildings, Alexandria, until noon, August 31st.—Specifications can be obtained at the Office of THE INSPECTING ENGINEER, EGYPTIAN AND SUDAN GOVERNMENTS, Queen Anne's Chambers, Westminster, S.W. 1. F 494

The Director-General,

India Store Department, Branch No. 16, Belvedere Road, Lambeth, S.E.1, REQUIRES:—

1. TURBO ALTERNATOR and CONDENSING PLANT for Power House.
2. BOILER ECONOMISER, PIPEWORK, etc., for Power House.
3. COOLING TOWER for Power House.

Tenders due on the 15th August, 1924.
Tender forms obtainable from above. F 469

TO CRANE MAKERS.

ELECTRIC WHARF CRANES.

The Dublin Port and Docks Board is prepared to receive

Tenders for the Supply of

TWO 2-ton ELECTRICALLY DRIVEN WHARF CRANES.

The Specification, together with outline drawing, can be obtained at the Office of the Engineer of the Board, JOSEPH MALLAGH, Esq., Assoc.M.Inst.C.E., East Wall, Dublin.

Tenders, marked on the outside of cover "Tender for Electric Wharf Cranes," must be delivered by post, sealed, prepaid and addressed to the SECRETARY, Port and Docks Office, Westmoreland Street, Dublin, on or before Wednesday, August 27th, 1924.

The Board does not bind itself to accept the lowest or any Tender.

By Order,
R. H. BAILEY,
Secretary.
Dublin Port and Docks Office.
29th July, 1924. F 470

THE BURMA RAILWAYS COMPANY, LIMITED.

The Board of Directors of the Burma Railways Company, Limited, are prepared to receive

Tenders for the Supply of :—

SEVEN LOCOMOTIVE ENGINES AND TENDERS (4-6-0 Standard Superheated mixed Type) "K" Class.

For each copy of the specification a fee of £2 will be charged, which fee is not returnable. Tenders, enclosed in sealed envelopes, addressed to "The Chairman and Directors," and endorsed "Tender for Locomotive Engines and Tenders," must be delivered at the Company's Offices not later than Noon, on Monday, the 25th August, 1924.

The Directors do not bind themselves to accept any or the lowest Tenders, and reserve the right to divide the order.

By order of the Board,
F. C. FRANKS,
Secretary.
193, Gresham House,
Old Broad Street,
London, E.C.2.
30th July, 1924. F 479

METROPOLITAN WATER BOARD.

DISPOSAL of 1000 tons (approx.) of 75 lb. & 90 to 95 lb. F.B. STEEL RAILS.

The Metropolitan Water Board invite

Tenders for the Purchase and

REMOVAL of approximately 343 tons of 90 to 95 lb. and 650 tons of 75 lb. RAILS, second-hand, and all in good condition, lying stacked at the Board's Littleton Reservoir Works (under construction) near Staines, Middlesex.

These rails may be seen at the above works at any time between NINE a.m. and FOUR p.m. (Saturdays excepted), on application to the Board's Contractors, S. PEARSON & SON (Contracting Department), Ltd., at their offices at Ashford, Middlesex.

Forms of Tender and Conditions of Contract may be obtained on and after 30th July, 1924, from the Chief Engineer, Metropolitan Water Board, New River Head, Rosebery Avenue, E.C. 1 (Room 156) by personal application, or on receipt of a stamped addressed envelope.

Tenders must be made on the official forms, addressed to "The Clerk, Metropolitan Water Board, 173, Rosebery Avenue, E.C. 1," and endorsed "Tender for Rails, Littleton Reservoir," and delivered to the Offices of the Board not later than ELEVEN a.m., on Wednesday, 13th August, 1924.

The Board do not bind themselves to accept the highest or any Tender.

G. F. STRINGER,
Clerk of the Board.
Offices of the Board,
New River Head,
173, Rosebery Avenue, E.C.1.
28th July, 1924. F 478

APPOINTMENTS OPEN.

UNIVERSITY COLLEGE OF SWANSEA.

Applications are Invited for

the POST of LECTURER in CIVIL ENGINEERING. Salary £500 per annum. The appointment will date from October 1st, 1924.

Further particulars may be obtained from the undersigned, by whom applications must be received on or before August 23rd, 1924.

EDWIN DREW, Registrar.
Singleton Park, Swansea. F 409

NEWCASTLE-UPON-TYNE EDUCATION COMMITTEE.

RUTHERFORD TECHNICAL COLLEGE.

Principal: C. L. ECLAIR-HEATH, Wh.Sc., A.M.I.M.E.

Applications are Invited for

APPOINTMENT of a LECTURER in MECHANICAL ENGINEERING. Applicants should have had a good technical and scientific education in a University or Technical College, have obtained a degree or its equivalent, and have had good Drawing Office and Works experience. It is desirable that candidates should have experience in the design and manufacture of internal combustion engines (including Diesel) and possess a good knowledge of hydraulics.

Salary according to Burnham Technical Scale, less 5 per cent.

Applications (on form to be obtained by sending stamped addressed foolscap envelope) to be returned to the undersigned not later than Tuesday, 19th August, 1924.

THOS. WALLING,
Director of Education,
Education Office, Northumberland Road. F 416

Experienced and Up-to-date

COST ACCOUNTANT REQUIRED, must be capable of producing accurate costs, fixing departmental charges and proving figures to be reliable on monthly profit and loss statement. 100 men. State age, wage required and full details of experience.—Address, F 454, Offices of ENGINEERING.

India.—Wanted, First-class

MAN as MANAGER of Railway Wagon Department of important Engineering firm. Excellent opportunity for thoroughly capable man. —Write, stating age, with full particulars of training and experience, and copies of testimonials, to Z.W. 177, c/o DEACONS, Leadenhall Street, London. F 483

Assistants (Two) Required

by the GOVERNMENT OF CEYLON for service in the Architectural Office of the PUBLIC WORKS DEPARTMENT, for a period of three years with possible permanency. Salary £500, rising by annual increments of £30 to £560 a year; and thence (if appointment is made permanent) to £960 per annum with efficiency bar at £720, payable locally in rupees at the Government rate of exchange of fifteen rupees to the £1. Free passages. Candidates, preferably unmarried, aged 26-30, must have passed examination for Associate Membership of the R.I.B.A. or the Membership of Society of Architects, and have special experience in the actual design and construction of reinforced concrete buildings and of steel-framed buildings. Preferably with war service.

Apply at once by letter, stating age, qualifications and experience, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W.1, quoting M/12945. F 455

ADMINISTRATIVE COUNTY OF LONDON.

The London County Council invites

Applications from Suitably

Qualified Persons for a POSITION of TECHNICAL (ENGINEERING) ASSISTANT on the permanent staff in the Architect's Department. The commencing salary will be £180 a year, rising by annual increments of £15 to £240 a year with a possibility of promotion. The salary is based on pre-war conditions and is subject at present to temporary additions on the Civil Service Scale fluctuating according to the cost of living. The total commencing remuneration is on the present basis £285 15s. 5d. a year. The next revision of the temporary additions will take place not later than 1st September, 1924.

Candidates should be engineering assistants having a sound knowledge of mathematics, and practical experience required to check calculations and examine working drawings of steel frame buildings and reinforced concrete structures.

Members of the Council's staff may apply. Candidates must be under 40 years of age on 9th September, 1924. Due weight will be given to the claims of those who served or attempted to serve in H.M. Forces during the Great War. Candidates who did not so serve in H.M. Armed Forces must be natural-born British subjects.

Apply for forms (containing full details) to the Clerk of the Council, The County Hall, Westminster Bridge, S.E.1. Stamped addressed foolscap envelope necessary. Forms must be returned not later than Eleven a.m. on 9th September, 1924. Canvassing disqualifies.

JAMES BIRD,
Clerk of the London County Council. F 447

Assistant Charge Engineer.—

REQUIRED ASSISTANT CHARGE ENGINEER in London Power Station. Salary commencing Grade 9 rising to 8B, Class F. Applicants must have had at least three years' mechanical experience; received a Public or Secondary School and technical education. Preference will be given to applicants between the ages of 26 and 35 who have already held positions in High Tension Alternating Power Stations. Application to be made on forms which can be obtained on or after August 1st, from the CHIEF ENGINEER, 60, Eden Grove, Holloway, N. 7, same to be returned not later than August 15, 1924. F 451

The Royal Air Force REQUIRES ELECTRICIANS, ELECTRICAL FITTERS, ENGINE DRIVER FITTERS, POWER STATION ENGINEERS and WIRELESS OPERATORS. Age limits 18 to 30. Pay from 24/6d. to 38/6d. per week, on enlistment, and all found. Allowance for wife and children to men 26 and over.—Write, stating age, or call, INSPECTOR OF RECRUITING, R.A.F., 4, Henrietta Street, Covent Garden, London, W.C.2. F 214

Assistant Metallurgical CHEMIST with Works experience REQUIRED for Laboratory of HARLAND AND WOLFF, LIMITED, Shipbuilders and Engineers, Belfast. State age, experience and salary. F 484

THE GOVERNMENT OF INDIA require the

Services of an Assistant CONTROLLER OF INSPECTION for the Indian Stores Department.

Three years' agreement in the first instance. Pay at the rate of Rs. 950 per mensem, rising by annual increments of Rs. 50 per mensem, to Rs. 1200 per mensem with certain allowances.

Candidates must be of good general education, should have served an apprenticeship of not less than three years in engineering workshops, and possess drawing office experience. They should have obtained five years' practical experience in a responsible position, experience as an Inspector of Engineering Stores being essential. Wide experience in inspection of steel bridgework and structures is also required. They should have obtained the Associate Membership of a recognised Institution of Engineers or University Degree, or possess equivalent qualifications.

Letters of application, stating full particulars of age, education, training and experience, giving dates, COPIES of testimonials and references, will be received not later than 16th August, 1924, by the Secretary to the HIGH COMMISSIONER FOR INDIA, 42, Grosvenor Gardens, London, S.W.1, from whom further particulars may be obtained. August, 1924. F 483

Civil Engineers REQUIRED by the GOVERNMENT of CEYLON for appointment as Irrigation Engineers, for three years in the first instance.

Salary £500, rising to £600 a year by annual increments of £40 (£600 on attaining 30 years of age). Free passage provided. Candidates, 26 to 31 years of age, unmarried, must have had war service and passed the examinations to qualify for Associate Membership of the Institution of Civil Engineers, or hold equivalent professional qualifications, and have had at least three years' practical experience on waterworks, drainage, or harbour and dock works.—Apply at once in writing, giving age and brief details of qualifications and experience to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1, quoting at head of application M/12653. F 495

General Fitter Required by the GOVERNMENT of the GOLD COAST, for the PUBLIC WORKS DEPARTMENT, for two tours of from 12 to 18 months' service with possible permanency. Salary £400–£12–£500 a year. Outfit allowance of £45 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 26-35, should possess a thorough knowledge of general mechanical and electrical engineering, including experience in power station work, and be experienced in the running and maintenance of steam and internal combustion engines, electrical machinery, and the usual woodworking and engineers' workshop machinery. Preference will be given to candidates who, in addition, have had experience in carrying out repairs to motor cars and lorries.—Apply at once by letter, stating age and particulars of experience to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1, quoting M/12938. F 496

Required, Civil Engineer (young), as Assistant to Resident Engineer for work on all parts of a railway in Central America. Climate tropical. Knowledge of Spanish preferable. Write, full particulars of previous experience, age, etc., with copies of testimonials, to D.D., c/o J. W. VICKERS & Co., LTD., 5, Nicholas Lane, E.C.4. F 474

Assistant Engineers (2) REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT for two tours of not less than 12 nor more than 18 months' service, with possible extension. Salary, £480 a year for first three years of service, then £510, rising to £720 a year by annual increments of £30, and thereafter to £920 a year by annual increments of £40. Outfit allowance of £60 on first appointment. Free quarters and passages, and liberal leave on full salary. Candidates, age 25 to 35, preferably unmarried, must have had good general education and be A.M.I.C.E., or hold equivalent qualifications. They must have had proper technical training and have had not less than two years' subsequent experience on large Engineering or Municipal Works. Preference given to candidates with experience of Waterworks construction.—Apply at once by letter, stating age, qualifications and experience, also whether married or single, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W.1, quoting reference M/12963. F 480

Senior Draughtsman.—WANTED, by firm in West London District, First-class SENIOR DRAUGHTSMAN, for work on Aero Engine design.—Address, giving full particulars of past experience and salary required, F 436, Offices of ENGINEERING.

Wanted, for the North Midlands, DRAUGHTSMEN with experience in Steam Winders design and details preferably with knowledge of Electric Winders. State age, detailed particulars of experience and salary required.—Address, F 464, Offices of ENGINEERING.

Testing

2137

A Monthly International Journal Devoted to the Field of Testing Materials, Structures and Machinery.

Edited with the Collaboration of Experts in All Industrial Countries of the World.

Subscription, $15.00 per Annum

PULLMAN PUBLISHING COMPANY

Pullman Building, Madison Square Station NEW YORK, U.S.A.

Wanted for Large Marine Engine Works on the North-East Coast, a thoroughly qualified DRAUGHTSMAN, of good education, with experience in Marine Auxiliaries.—Address, stating age, salary required, and giving full particulars of experience and technical training, F 473, Offices of ENGINEERING.

Designing Draughtsman for light mechanical work, preferably with experience of Submarine Mines.—Address, F 449, Offices of ENGINEERING.

Wanted, Good Draughtsman for Engineering Works in the Midlands. Must be accustomed to General Engineering. Only first-class men need apply.—Address, F 450, Offices of ENGINEERING.

Wanted, Good Draughtsman, used to Rolling Mills and Furnaces, and with a good knowledge of Machinery.—Address, by letter stating age, experience and salary required, F 398, Offices of ENGINEERING.

Wanted, Structural Steel- WORK DRAUGHTSMAN, thoroughly experienced in designing for and preparing fully detailed shop drawings for Steel Bridge and Roof Work. State age, details of experience, and salary required.—Apply, FRANCIS MORTON & CO., LTD., Engineers and Contractors, Hamilton Ironworks, Garston, Liverpool. F 402

Amos & Smith Ltd., Hull, beg to notify applicants that they have now appointed a Manager. F 486

COUNTY OF LONDON ELECTRIC SUPPLY COMPANY LIMITED.

BARKING POWER STATION.

The County of London Electric Supply Co., Ltd., thanks the applicants for the positions recently advertised for the Barking Power Station, and advises them the same have now been filled. F 488

SITUATIONS WANTED.

Naval Architect and Chief Draughtsman. Aged 32. Estimates, designs, construction and repairs, speciality small craft. Desires Post, inside or outside, home or abroad.—Address, F 63, Offices of ENGINEERING.

Sales Engineer, Age 31, DESIRES APPOINTMENT in a well-established and reputable firm. General practical Mechanical Engineering. Commercial knowledge. Drawing Office and Works experience. Represented a leading firm in the East for three years, with success as Manager. Also home experience. Energetic and Forceful. Excellent references.—Address, F 457, Offices of ENGINEERING.

Mechanical Engineer (23), DESIRES POST with prospects at home or abroad. Five years' apprenticeship first-class firm (patternshop, foundries, fitting and erecting shops, trials, etc.). Two years University. At present with consulting engineer of repute. Excellent testimonials.—Address, F 463, Offices of ENGINEERING.

Heating Engineer Seeks Position as Foreman or Manager, experienced in all classes of Heating; get out schemes and estimates for Works, Public Buildings, Churches, etc., Control men.—Address, F 490, Offices of ENGINEERING.

Marine Engineer, 18 years' experience as a senior on largest liners, First-class Board of Trade Certificate, ex-service Captain R.E., DESIRES POSITION as maintenance engineer, assistant manager of works, or charge of Plant. Energetic, ambitious and capable of handling large numbers of men.—Address, F 475, Offices of ENGINEERING.

TO ENGINEERING MANUFACTURERS AND EXPORTING FIRMS.

WHY NOT EXPAND FOREIGN BUSINESS?

Gentleman, University Gradu- ate and Memb. Inst. Civil Engineers, many years' experience in Engineering business, Argentine and Far East, is OPEN to ENGAGEMENT. Recently returned from Far East, where he has been managing important Engineering business for 14 years, handlingall kinds of machinery and engineering products. Good business connections Burmah, Straits, Siam, China. Would be of great assistance in developing and expanding foreign business, and undertake sole representation abroad. First-class references.—Address, F 476, Offices of ENGINEERING.

Hons. B.Sc. (Leeds, 1924) Mech. Engineering, with one year's shop experience Wishes to Enter a Good Firm; willing to spend two or more years in shops and drawing office. During this period remuneration unimportant.—Address, F 426, Offices of ENGINEERING.

Do You Require the Services of a first-class Mechanical Engineer? Age 32. First B.O.T. Certificate. Steady man. Ex. refs.—69, Whitbread Road, London, S.E.4. F 492

Practical Engineer and Draughtsman (33), DESIRES RE-ENGAGEMENT. Experience chemical and factory plant design and erection, development patent machinery, etc.—Address, F 489, Offices of ENGINEERING.

Chief Ship Draughtsman Desires Post. Designs, Estimates, New Construction, Repairs, Conversions, speciality small craft, any type. Considerable yard and office experience.—Address, F 493, Offices of ENGINEERING.

First-class Ratefixer Seeks Appointment. Many years' experience on all classes of work. Could introduce Piecework or Premium Bonus. Would take Position as Superintendent of Machine Shop.—Address, F 477, Offices of Engineering.

WORK WANTED.

J. Kirkaldy, Limited. WORKS: 2338 BURNT MILL, ESSEX.

We are organised to produce castings from 2 lbs. to 2 tons. Cast-iron, Semi-steel, and Non-ferrous castings. Coils of every description, Steel and Copper. Sheet Metal Work. Over 40 years' experience is at your service. Send your enquiries along.

WANTED, &c.

Company, with Large Well- equipped Works, comprising Machine, Boiler, Foundry, Pattern, Smith, Woodworking, Departments, DESIROUS of UNDERTAKING MANUFACTURE of any articles suitable for any or all the above Departments.—Address, F 440, Offices of ENGINEERING.

Live Agents, Established 1919, with well-appointed office (N.B. Coast) and car, DESIRE to REPRESENT one additional first-class Engineering FIRM. Only enterprising Company of high repute considered.—Address, F 471, Offices of ENGINEERING.

"Improvements in or relating to Method and Apparatus for the Production of Cast Steel Blanks." No. 15591 of 1915.

The Owner of the above Patent is DESIROUS of ARRANGING by LICENSE or otherwise on reasonable terms for the manufacture and commercial development of the invention. For particulars address, HERBERT HADDAN & CO., Chartered Patent Agents, 31 and 32, Bedford Street, Strand, London, W.C. 2. F 458

The Proprietors of Letters PATENT No. 8308 of 1916, Dust Collector; No. 101055 of 1916, Comminuting Body for Grinding Mill; No. 125012 of 1918, Comminuting Mill; No. 153575 of 1920, Tractor; No. 167863 of 1920, Roasting Furnace; and No. 173739 of 1921, Crusher, are DESIROUS of ENTERING into ARRANGEMENTS, by way of a license or otherwise, on reasonable terms, for the purpose of exploiting the above identified patents and insuring their practical working in Great Britain.—Address all enquiries to ALCHALCO, care of HAROLD BRAYSHAY, 728, Salisbury House, London Wall, E.C. 2. F 405

Wanted, Two Second-hand Cast Iron Covered Sectional FEED WATER TANKS, 15,000 gallon capacity, must be in good condition.—Offers, stating price f.o.r. South Wales, F 396, Offices of ENGINEERING.

PARTNERSHIPS.

IF YOU ARE SEEKING

A Partner or Partnership

or wish to Buy or Sell a BUSINESS or WORKS Write:—

Wheatley Kirk, Price & Co., 46, Watling Street, LONDON, E.C. 4.

ESTABLISHED OVER SEVENTY YEARS. 1875

AUCTION SALES.

Wheatley Kirk, Price & Co. (Established 1850)

Auctioneers AND VALUERS OF 1875

ENGINEERING WORKS, PLANT AND STOCK

46, WATLING STREET, LONDON, E.C. 4.

16, ALBERT SQ., MANCHESTER. 20, COLLINGWOOD ST., NEWCASTLE-ON-TYNE.

Telephones & Telegrams at each Address.

By Order of Messrs. WHEATLEY BROS., EAST KENT, between ASHFORD and HYTHE.

2½ miles from Smeeth Station, on the main line of the Southern Railway. Situated in an excellent AGRICULTURAL district adjoining the FAMOUS ROMNEY MARSH.

A unique opportunity to acquire the WELL ESTABLISHED, SUCCESSFUL AND FULLY EQUIPPED

ENGINEERING BUSINESS known as "GOLDENHURST WORKS," ALDINGTON.

Steel frame, by ARMSTRONG, 210 ft. by 35 ft., conveniently planned, and comprising PAINT SHOP, private lock-up GARAGE with INSPECTION PIT, OFFICES, model MACHINE SHOP, fitted with powerful LATHES, drills, milling machines, &c.; Heavy ENGINE REPAIR SHED for agricultural work, POWER HOUSE with CROSSLEY 17 h.p. SUCTION GAS ENGINE driving MAIN SHAFTING and LIGHTING DYNAMO, MACHINE and PETROL STORES; the whole standing in an area of about TWO ACRES held on lease for nearly 200 years, Ground Rent, £7 10s.

ELECTRIC LIGHT and WATER.

Messrs.

W. & B. Hobbs,

will SELL the above by AUCTION, at the Saracen's Head Hotel, Ashford, on TUESDAY, AUGUST 26th, at three p.m. as a GOING CONCERN.

Illustrated Particulars and Conditions of Sale from Messrs. HALLETT, CREERY & CO., Solicitors, Ashford, Lydd and Folkestone, and of the AUCTIONEERS, Ashford, Kent. F 465

FOR SALE.

To Boiler Buyers.—Vertical, Loco., Cornish, Launch, Field Tube. Air Receivers & Feed-water Heaters. —GRANTHAM BOILER & CRANK CO., LD., Grantham.

For Sale, 110 HP., National GAS ENGINE, complete with Generating Plant, Gas Producer, Tanks, etc., all in good working condition.—Apply, FRANCIS MORTON & CO., LTD., Garston, Liverpool. F 369

Portable Steam Engines, Two 10 N.H.P., Double Cylinder, modern type, 150 lbs. w.p.—HARRY H. GARDAM & CO., LIMITED, Staines. F 412

"METHOD AND APPARATUS FOR SEPARATING QUANTITIES OF MOLTEN GLASS OR LIKE MATERIAL FROM MASS." British Patent No. 109782, dated 16th September, 1916.

The Owners of the Above- mentioned Patent DESIRE to DISPOSE of the SAME, or to enter into working arrangements with a firm likely to be interested.—Particulars may be obtained from TECHNICAL RECORDS LIMITED, 59 and 60, Lincoln's Inn Fields, London, W.C.2. F 461

For Immediate Disposal, 120,000 gallons per hour Horizontal Triple Expansion Surface Condensing Worthington PUMPING ENGINE, with Duplex Double Acting Well Pumps, and Duplex Double Acting High Lift Pumps, not erected, as purchasing firm do not require delivery for 12 months. Can be inspected at Worthington Simpsons Works, Newark.—Address, F 345, Offices of ENGINEERING.

The Proprietors of Patents No. 135056, for a process for making Alloys rich in Lead, and No. 135702, for manufacture of Alloys of Copper, Zinc and Lead, are DESIROUS of SECURING the full Commercial Development and Practical Working of the Inventions by way of SALE of the PATENTS or by the grant of licences on reasonable terms.—Communications should be addressed in the first instance to ANDREWS AND BEAUMONT, 29, Southampton Buildings, London, W.C. 2. F 487

Lathe, "Buckton," 16 in. centres, 34 ft. bed.

Lathe, "Oldfield & Schofield," 16 in. centres, S.C. Lathe, 22 ft. 6 in. gap bed.

Chucking Lathe, "Redman" heavy, 15 in. centres, gap bed.

Lathe, "Niles" type, 12 in. centres, 12 ft. bed.

Lathe, "Wilson," 8 in. centres, 8 ft. bed.

Turret Lathe, "Libby," all-geared, 9 in. centres, 9 ft. bed.

Capstan Lathe, "Ward," single-geared, 6 in. centres.

Side Planer, "Richards," 24 ft. by 3 ft. 4 in.

Slotting Machines, "Muir," 8 in. and 12 in.

Vertical Millers, No. 5 "Kendall & Gent"; "Dickinson"; "Becker"; and "Newton."

Blanking Power Press, "Rhodes." Heavy geared.

Cold Sawing Machine, "Wagner," 17 in. saw.

Ball Bearing Disc Grinder, "Fish," 18 in.

Oscillating and Plain Tool Grinders, "Lumsden." Rebuilt.

Apply THE LUMSDEN MACHINE CO., LTD., Gateshead-on-Tyne. F 472

For Sale, &c., continued on page 4.

Armstrong Whitworth

Triple Geared LATHE, centres 16 in., bed 36 ft. surfacing, sliding and screwcutting. Little Used. Modern tool.—Address, F 462, Offices of ENGINEERING.

Overhead Electric Two-ton

RUNWAY (New) FOR SALE, Herbert Morris, cage operated, packed as just delivered, 230 feet with one bend, approximate height 28 feet. With or without 3 phase Motors 220 volts. Magnificent plant. Will sell at 25 per cent sacrifice. —Apply, C. L. STIFF & CO., LTD., Slag Breaker, East Ardsley, near Wakefield. F 448

ENGINEERING WORKS—LONDON, W.

Small Old-Established Free-

HOLD WATERSIDE WORKS with room for extension TO BE SOLD as a Going Concern, including valuable Machinery and Plant, Goodwill and Patent Rights. Low price to immediate purchaser.—Apply, FAREBROTHER, ELLIS & CO., 29, Fleet Street, E.C.4. F 446

The Proprietors of the British

Patent No. 172174, relating to "Multi-Stage Centrifugal Pumps," are PREPARED to ACCEPT Tenders for the MANUFACTURE of the PUMPS in Great Britain, or to consider applications for the grant of licences, or the disposal by purchase of their rights.

Applications, in the first instance, should be addressed to KILBURN & STRODE, 31, High Holborn, London, W.C.1. F 460

URGENT—SPACE REQUIRED.

£1750 is the Price of 1000

Kw. (2-500 Kw.) Parsons TURBINE GENERATING SETS, 230 Volts D.C., with Klein Condensing Plant and spare armature complete. Steam 150 lbs.

Also available 600 Kw. Brush-Parsons EXHAUST TURBINE SET, 230 volts D.C., and B.C.C.-Willans EXHAUST TURBINE SET, 200 Kw., 460 Volts D.C.—JENNINGS, West Walls, Newcastle-on-Tyne. 1701

For Sale.—Floating Electric

POWER STATION. 1000 Kw., with Parsons Geared Turbines, and Generators D.C. 110/575 volts and A.C. 220/7600 volts. Steam from 6 Oil-fired Boilers. Installed on Barge 165 ft. by 23½ ft. with workshop and storeroom. Also Fuel Oil Steel Barge of 60 tons capacity, and 500 Kw. Vickers Rotary Converter and Transformer converting A.C. into 440 volts D.C.

For further particulars apply:—

SECRETARY,

FORTH SHIPBUILDING & ENGINEERING CO. (1921), LTD.,

29, Great St. Helen's,

E.C.3. 1823

New Electric Plant for Sale.

TWO MOTORS, 60 B.HP, 975 revs., 3-phase 2000 volts., 50 cycles, slipring type, with brush lifting and short circuiting gear, belt drive pulley and slide rails.

TWO OIL IMMERSED STARTERS, 80 amps.

ONE THREE PHASE TRANSFORMER, 25 KVA, 50 cycles, 2100/390 volts., oil immersed.

TWO KILOWATT METERS, from 50 to 5 amps., for primary 2100 volts., secondary 100 volts.

TWO POTENTIAL TRANSFORMERS, 2100 volts. to 100 volts.

All above made by Siemens Schuckert.

Packed for Shipment. Price, £250 0s. 0d., the lot cash. Can be inspected by appointment.

Newcastle-on-Tyne district.

Address, F 467, Offices of ENGINEERING.

LAMBETH WORKHOUSE, PRINCE'S ROAD, KENNINGTON, LONDON—NEAR ALBERT EMBANKMENT, AND VAUXHALL RAILWAY STATION (SOUTHERN RAILWAY).

This Desirable Freehold

PROPERTY FOR DISPOSAL. Two acres in extent, comprising substantial buildings containing approximately 51,360 super. feet floor space and 928,249 per cubic feet of Buildings.

Frontages approximately:—

PRINCE'S ROAD ... 410 ft. 0 in.
EYERS STREET ... 200 ft. 0 in.
VAUXHALL STREET 286 ft. 0 in.

Apply, CLERK TO THE GUARDIANS, Guardians' Offices, Brook Street, Kennington Road, S.E. 11, to whom all enquiries should be addressed. F 445

The H. A. Dudgeon Machine Co.

Head Office & Showroom: Friars Road, Coventry.

Phone: 2129. Telegrams: "Dudgeon, Coventry."

London Office:

11, Queen Victoria Street, London, E.C.4.

'Phone: City 1253. 'Grams: "Withatool, Cannon, London."

New and Secondhand

MACHINE TOOLS

*2—No. 4 HERBERT CAPSTANS.
*2—6¼ in. WARD CAPSTANS.
*18 in. SWING HEAVY DUTY LATHE.
8 in. by 18 in. PLAIN GRINDERS.
*WALKER 12 in. RING GRINDER.
*No. 60 HEALD CYLINDER GRINDER.
*SIGOURNEY & CORONA 2-SPINDLE DRILLS.
*SNYDER 25 in. DRILL.
*NEW UNIVERSAL MILLER.
*1A PARKSON PLAIN MILLER.

THIS WEEK'S BARGAIN.

LANDIS 6 in. by 18 in. Self-contained PLAIN GRINDER. Latest design. Condition equal to new, £200.

* In our Coventry Stock. F 361

For Sale, Motor Generator, by

Lancashire Dynamo Co., Ltd., 1920, Comprising, 480 volt, D.C. Motor, coupled to 105 volt, 820 ampere compound interpole Generator, complete with Switchboard.

THE PHŒNIX ELECTRICAL CO., LTD., 17, Oswald Street, Glasgow. C 475

WESTHOUGHTON.

For Sale outright, or on Yearly

Rental, VALUABLE FREEHOLD ENGINEERING WORKS, in bays approximately 130 yards in length, and covering some 15,000 square yards of concreted floor space, provided practically throughout with overhead cranes, electric power, either produced on site with present plant, or, alternatively, supply company's mains already fixed.

Some 4½ acres with connection to Railway Main Line. Good Offices, Water and Gas.

Further particulars, MANAGER,
WESTHOUGHTON COAL & CANNEL CO., LTD.,
Westhoughton. F 382

Dismantling of Railway

SIDINGS at

KIDBROOKE.

FOR SALE.

About Two miles of RAILWAY TRACK,

BULL HEAD & DOUBLE HEAD,

with Switches and Crossings, Chairs and Sleepers.

Eleven Buffer Stops strongly built to Railway specification.

Six Wrot Iron Lamp Standards with Ladders and Lamps.

Inspection invited.
Prices on Application.

THOS. W. WARD, Ltd.,
Albion Works, Sheffield,
or
Thames Road, Silvertown, E. 16. F 356

650 B.HP. Horizontal Corliss

Valve Condensing STEAM ENGINE, by Rick Hargreaves, Rope Flywheel.

Marshall Class "LHC" Horizontal Cross Compound Condensing STEAM ENGINE, Cylinders 11 in. and 19 in. dia. by 3 ft. stroke, Rope Flywheel, Belliss 200 HP. High-Speed ENCLOSED ENGINE, new 1918, 110 lbs. w.p., "V" type Valves.

Weir BOILER FEED PUMP, Steam Cylinder 14½ in., Water 10½ in., by 20 in. stroke.

Cornish BOILER, by Woodhouse & Mitchell, 20 ft. long, 6 ft. diameter, 100 lbs. w.p.

HARRY H. GARDAM & CO., LIMITED, Staines.

TWO HORIZONTAL DROP VALVE COMPOUND STEAM ENGINES, by Robey, FOR SALE, 140 HP. and 200 HP., cross coupled and tandem, respectively. Modern. Low price.

HARRY H. GARDAM & CO., LIMITED, Staines. F 354

For Sale, Motor-Driven Air

COMPRESSOR, by Belliss & Morcom. 1000 cubic ft. per min. 100 lbs. pressure, with 500 volt D.C. motor.—THE PHŒNIX ELECTRICAL CO., LTD., 17, Oswald Street, Glasgow. D 231

Big Bargain.—16 Kw. Petrol

Electric GENERATING SET, comprising Dorman Four-Cylinder Vertical Engine, 32 B.HP., 1000 Revs., Fan-cooled Radiator, Fuel and Water Tank, direct connected to 16 Kw. Semi-enclosed Dynamo. Fourpole interpole, Carbon Brushes, ring oiling bearings. Dixie Magneto. Price £100 or nearest.—MIDLANDS BELT, Huntingdon Street, Nottingham. F 326

Steel Screwed and Socketed

PIPING.
FOR IMMEDIATE DELIVERY.

6 in.	-	30,000 feet.
8 in.	-	9,360 ,,
10 in.	-	18,000 ,,
12 in.	-	14,000 ,,

Full particulars from
THOS. W. WARD LTD.,
ALBION WORKS, SHEFFIELD.
London Works, Silvertown, E. 16. F 21

Electric Generating Plant for SALE.

Direct Current.

Two	26 Kw.	105 Volts.	"Howden-B.E.H."
Two	52 ,,	,, ,,	"Brotherhood-Laurence Scott."
Two	100 ,,	440/500 ,,	Gerrett Semi-Portable.
One	120 ,,	110 ,,	"Belliss-Siemens."
One	150 ,,	220 ,,	"Howden-Lanc. Dynamo."
Two	200 ,,	,, ,,	"W. H. ALLEN."
Two	200 ,,	,, ,,	"Belliss-Siemens."
One	240 ,,	440/500 ,,	"Belliss-Phœnix Dynamo.
One	375 ,,	250 ,,	"Allen-Westinghouse."
One	400 ,,	240 ,,	"Howden-Siemens."
One	500 ,,	230 ,,	"Howden-B.T.H."
One	500 ,,	230 ,,	"Belliss-B.T.H."
One	500 ,,	500 ,,	Metropolitan Vickers Turbo.
One	600 ,,	500 ,,	"Belliss-Mather & Platt."
One	750 ,,	220 ,,	"Parsons-Crompton" Geared Turbo.
One	1250 ,,	250 ,,	"Belliss" Turbo.

Alternating Current, 3-Phase, 50 Periods.

One	400 Kw.	550/550 Volts.	"Howden-G.E.C."
One	750 ,,	,, ,,	"Metropolitan Vickers."
One	850 ,,	,, ,,	"Fraser & Chalmers."
Two	1000 ,,	,, ,,	"Metropolitan-Vickers."
One	1000 ,,	3300 ,,	"B.T.H."
Two	1000 ,,	,, ,,	"Metropolitan-Vickers."
One	2000 ,,	500/550 ,,	,, ,,
One	3000 ,,	6600 ,,	"B.T.H." ,,

All above are modern, and condensing plant is available in nearly all cases.

We can also offer several Suction Gas and Diesel Sets, Babcock Boilers up to 30,000 lbs. per hour, and a very large number of motors, generators, Motor-generators, rotary converters, etc.

Enquiries Invited.

THE PHŒNIX ELECTRICAL COMPANY, LTD., 17, OSWALD STREET, GLASGOW. 2217

Diesel Engines, 300, 530, 800

1200 and 1750 B.HP., M.A.N., with or without dynamos; condition as new. About one-third market price; seen London. For all sizes above sizes in stock.

HICK DIESEL OIL ENGINES, LTD., 70, Queen Street, E.C. 4. 3010

Alfred Herbert Ltd.,

'Phone: 860 (8 lines). COVENTRY, Wires: Lathes, Coventry.

Surplus Machines.

You are cordially invited to inspect the large stocks of NEW, RE-CONDITIONED and SECOND-HAND machines which we are offering at specially reduced prices from our Coventry Warehouse. The following is a selection:—

AUTOMATIC MACHINES.

1 in. by 5 in. New Britain Six-Spindle Automatic. (Re-conditioned.)

⅜ in., ½ in., ¾ in., 1½ in. Cleveland Model "A" Automatics. (Re-conditioned.)

No. 6 Alfred Herbert Auto-Lathes, S.S. Feeds, 19 in. swing, 10 in. stroke of capstan. (Re-conditioned.)

DRILLING MACHINES.

Alfred Herbert Single-Spindle B.B. Drill with automatic feed, pump and fittings. (Re-conditioned.)

6 ft. 0 in. McKendrick Girder Type Radial Drill with single speed motor drive—but minus motor. (New.)

28 in. American Tool Works Sliding-Head Upright Drill, C.P. drive, auto feed with 2-speed S.C. countershaft, and 18 in. by 48 in. Rectangular table. (Second-hand.)

GRINDING MACHINES.

No. 3 12 in. by 42 in. Landis Univ. Grinder with countershaft a full equipment. (Re-conditioned.)

No. 2 Lumsden Oscillating Tool Grinders (B.B.), including curved rake attach., Univ. Tool Holder and S.C. countershaft. (Re-conditioned.)

No. 4 Van Norman Internal Grinder with Auto. Feed to Table, Power cross feed and water attachment, three wheel arbors, grinding wheel and countershaft. (New.)

LATHES (CENTRE).

9 in. by 8 ft. 0 in. Greaves Klusman S.S. & Sc. Lathe, C.P. Head, Semi-Quick Change, 1 11/16 in. hole through spindle, 4 ft. 6 in. between centres. (Re-conditioned.)

7 in. by 6 ft. 0 in. Hendey S.S. & Sc. Lathe, C.P. drive, D.B.G., Q.C. 1 in. hole through spindle, 9 ft. 10 in. between centres. (Re-conditioned.)

5½ in. by 5 ft. 0 in Atkins S.S. & Sc. Lathe C.P. drive, 1 in. hole through spindle. 2 ft. 7 in. between centres. (New.)

PLANING MACHINES.

30 in. by 30 in. by 8 ft. 0 in. Redman Planers, with two heads, V.S. countershaft and table. (Re-conditioned.)

60 in. by 60 in. by 16 ft. 0 in. Stirk H.S. Planers with three heads, arranged for motor drive (minus motor). (Second-hand.)

108 in. by 108 in. by 20 ft. 0 in. Shanks Planer with two swivel heads, complete with motor. (Second-hand.)

SHAPING AND SLOTTING MACHINES.

18 in. Greenwood and Batley Shaper, C.P. drive, complete with swivel tool post and countershaft. (Second-hand.)

6 in. and 8 in. Butler Slotting Machines, fitted with circular tables, 15 in. and 20 in. respectively. (Re-conditioned.)

9 in. Wilkinson Slotters, C.P. drive, with 24 in. Compound Circular Table, countershaft and spanners (Max. traverse 18 in.). (New.)

SURPLUS LIST No. 11 GIVES ADDITIONAL DETAILS AND PRICES. F 463

BEST BRITISH STEEL

We manufacture the BEST BRIGHT DRAWN STEEL for all purposes. We supply it in HEXAGONS, ROUNDS, SQUARES AND FLATS.

Send us YOUR enquiry TO-DAY!

We are also makers of the BEST STEEL BOLTS, NUTS, WASHERS, SET SCREWS, STUDS, &c.

Let us Quote YOU! 9080

HAMPTON & DEAN,
CLIFTON WORKS - - WEDNESBURY.
Telephone—Darlaston 89. Telegrams—"Clifton, Darlaston."

LONDON OFFICE - 30, ST. MARY AXE, E.C. 3.
Telephone—Avenue 1432. Telegrams—"Busiris, Ldn., London."

Wrights STEEL WIRE ROPES
For every Engineering Purpose
See illustrated advertisement page 36, June 6.

JOHN SPENCER, LD.
WEDNESBURY.
IRON & STEEL 3089
TUBES
POLES. STEAM MAINS. TUBULAR PILES. &c.

See illustrated advert. last week and next.
SMITH'S RELIABLE CRANES
THOMAS SMITH & SONS (RODLEY), LTD., NR. LEEDS.

"GOLIATH"
PNEUMATIC TOOLS.

Catalogue on application.

SELSON ENGINEERING CO., LTD.,
85, Queen Victoria St., London, E.C.4.

A RATIONAL FORM OF DRAFT TUBE FOR WATER-TURBINES.

By Professor A. MELOVICH, Moscow, Petrovskaia Academy.

IN an extremely interesting paper, published in ENGINEERING, Vol. cxiv, pp. 31-35, July 14, 1922, by Mr. Frank H. Rogers, describing the construction of the new Queenston Power Station, Ontario, Niagara, it was stated that the turbines were, for purposes of comparison, provided with two different forms of draft tube. The No. 2 unit was provided with the Moody spreading draft tube and the No. 1 unit with a sharply-curved draft tube, of corresponding overall dimensions. As in other respects the two turbines are of identical construction, we can determine the relative efficiency of the two forms of the draft tube by a comparative examination of the performances of the units. Attempts to discover the most rational form of draft-tube by this direct experimental method deserve approbation, but in order that the results obtained should be decisive it is indispensable that the tubes to be compared should both have theoretically correct forms, that is to say, such forms as will be entirely filled with the flow without the formation of dead-water spaces. Unless this condition be fulfilled, the true cross-sectional area of the flow will not be equal to the cross-section of the tube. When this is the case, the real velocities of the flow may differ very considerably from velocities calculated from the tube section, and thus two different draft tubes may cease to be comparable.

I would fix the attention of the constructors of the Queenston Power Station and of all engineers generally, on the fundamental importance of the foregoing considerations. There are strong theoretical reasons for supposing that the form of the draft tube for the No. 1 unit of the Queenston Station, as represented in Fig. 1, does not fulfill the condition for full bore flow. Having at my disposal no correct data or sketches of the draft tubes in question I will base the observations which follow upon the data and the sketches given in the paper abovementioned, and from these will deduce roughly the requisite data, which will be near enough to the truth for the purpose of the present paper.

The turbines of the Queenston Power Station are working under a head $H = 305$ ft. with a discharge $Q = 1{,}750$ cubit feet per second, and the theoretical efficiency is 92 per cent. They should therefore develop the power

$$N = 0{,}103\ Q\,H = 55{,}000 \text{ h.p.}$$

The whole of the discharge passes through the draft tube, Fig. 1, which at the inlet is of circular section with a diameter $d = 9$ ft., so that the area of the cross-section is 63·6 sq. ft. At the outlet the section is rectangular, measuring 12·5 ft. × 37·5 ft., which gives an area of approximately 468·75 sq. ft.

Calculating the velocities of the water flow at the inlet and at the outlet of the draft tube from the corresponding areas of their normal sections we find that at the inlet $V_0 = 27{\cdot}5$ ft. per second, and at the outlet $V_1 = 3{\cdot}7$ ft. per second, the ratio of the two being 7·4. The very considerable expansion of the draft tube occurs, in the case of the Queenston Station principally and quite correctly, in the direction parallel to the axis of the tube's curvature, so that the breadth of the tube at the outlet, 37·5 ft., is three times more than the height, 12·5 ft. But the change of the tube's direction from the vertical to the horizontal occurs in so steep a manner, and the radius of curvature of its exterior side is so small, that—as shown in my paper on "The approximate formula of the loss of head at the curving of the tube and its consequences," Wiestnik Ingenerow—*Engineering Herald*, N 19, Petrograd, 1915—below the curving of the tube the flow cannot entirely fill the cross-sectional area of the tube, because there its breadth cannot be more than 5 ft., and the effective boundaries of the flow will have the form shown in Fig. 1 by the curve *a b*. Between the boundary surface of the real flow and the upper side of the tube there will be formed a dead-water space C filled with eddies having a circulation as it is shown by the arrows in Fig. 1.

With a flow of this kind, the effective depth at the outlet will not be equal to *eg*, but only to *fg*, and also instead of the calculated discharge area 12·5 ft. × 37·5 ft. = 468·75 sq. ft. we get an effective area of only 5 ft. × 37·5 ft. = 187·5 sq. ft.

Fig. 1.

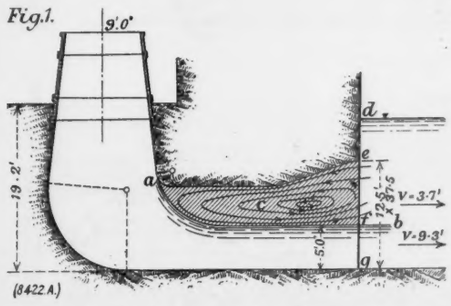
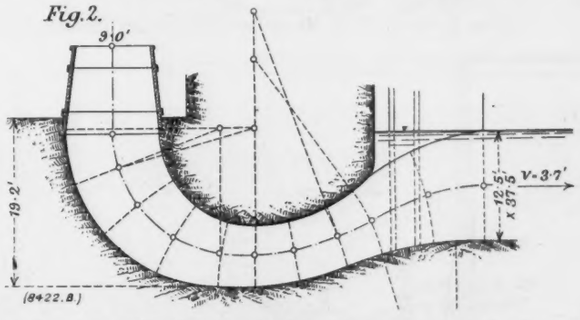


Fig. 2.



The velocity at the outlet of the draft tube, in correspondence with the real area of discharge, will therefore be $V_1^1 = 9{\cdot}3$ ft., instead of the calculated 3·7 ft. It is therefore two and a-half times more than supposed, and the real expansion of the tube is thus only 3 instead of 7·7.

The increase of velocity at the outlet of the draft tube implies a loss of head

$$H_v = \frac{v_1^{12} - v_1^2}{2g} = \frac{9{\cdot}3^2 - 3{\cdot}7^2}{2 \times 32{\cdot}18} = 1{\cdot}12 \text{ ft.}$$

and a loss of power for the unit $N = 300$ h.p.

From the foregoing, we see that the bad form of the draft tube leads to a loss of power of 300 h.p., and that the efficiency of the unit is thereby reduced to 91·46 per cent. instead of 92 per cent., which means a reduction of 0·57 per cent. The comparatively small influence of the form of the flow in the Queenston station's draft tube on the performance can be explained by a very high head (305 ft.) under which the turbines are there working. But the loss will be proportionately more considerable the less the head, and may be very considerable under small heads, for which the form of the draft tube must be determined with particular care. It is therefore very desirable to make the most exact and detailed hydrometric measurements at the outlet of the draft tube at the Queenston station. Such measurements should include a full investigation of the velocity distribution over the cross-sectional area at the discharge end *dg*.

If such measurements confirm the accuracy of the flow represented in Fig. 1, we shall have as a result the impossibility of making a fair comparison between this tube and the Moody spreading draft tube.

Meanwhile a little change in the form of the tube in the plane of its curvature, whilst keeping within the same structural limits, will give to the tube a correct theoretical form, which is indicated in Fig. 2, drawn, of course, to the same scale as Fig. 1. In this modified tube there will be no dead-water spaces, and the calculated velocities will be equal to the real ones. Moreover, the outlet of the draft tube is raised in such a manner that the depth of the discharge tube is equal to the final height of the draft tube at the outlet, namely, 12·5 ft. In this way we can avoid the energy losses of the flow due to shock, which would occur in the case of the tube having the form shown in Fig. 1.

As a final result of such a change of form of the draft tube we shall really have the desired values of velocity (3·7) at the outlet.

Such a tube can be compared with the Moody spreading draft tube, but it will, I believe, work more satisfactorily, because the flowing out of the water in the circular channel of the Moody tube and the flowing in of water in that channel are associated with great additional resistance to the flow. This resistance reduces considerably the effect of the theoretically correct flow in the first vertical part of the tube. I consider the appearance of the dead-water spaces below the curve of the tube as the most considerable effect of its construction; and similar defects vitiate the working of almost all draft tubes constructed till now. The theory of the curved flow gives detailed indications as to how the formation of dead-water spaces may be avoided. If there are no dead-water spaces, the simplest construction of tube will give the best results in working.

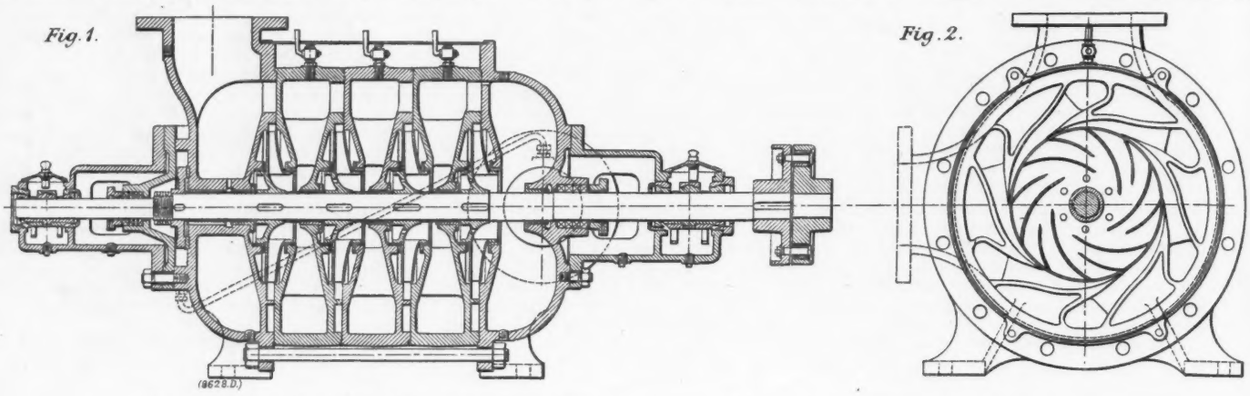
As to the correctness of the tube form, it would be also very interesting to discuss the form of the spiral turbine entrances at the Queenston Power Station, but, unfortunately, the description does not give the data necessary for such a discussion.

FIRE PROTECTION SERVICE AT THE BRITISH EMPIRE EXHIBITION.—I.

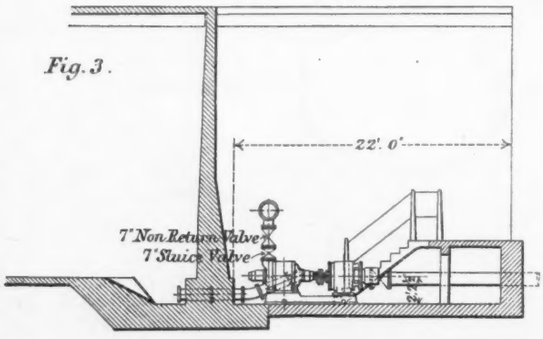
As has been the case in other directions, the fire service arrangements at the British Empire Exhibition at Wembley serve two purposes. They are intended at once to provide protection in case of outbreak and also to serve as exhibits of various manufacturers. The water supply for the service is provided by a circular 1,000,000-gallon reinforced concrete tank near the Stadium at which is arranged a high-pressure pumping station. This is fitted with three electrically-driven 7-in. four-stage high-lift pumps made by Messrs. Worthington-Simpson, Limited, Kingsway, London, W.C.2. These pumps are illustrated in Figs. 1 and 2, page 154, while the layout of the station is shown in Figs. 3, 4 and 5, a view of the interior being given in Fig. 6. The sets have a combined capacity of 120,000 gallons per hour, against a pressure of 160 lb. per square inch, equivalent to a head of about 370 ft. Their speed is 1,450 r.p.m. Each draws direct from the reservoir behind the pump room. The suction and delivery of the pumps are both 7 in. and the three pumps deliver into a common 12-in. main running above them, as shown in Fig. 4.

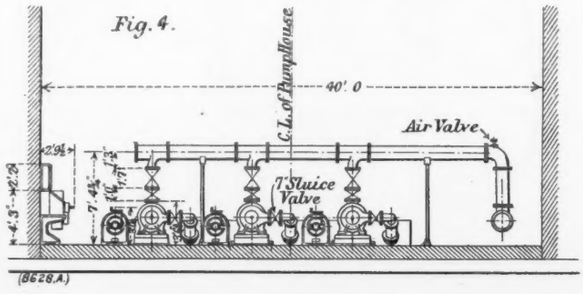
The pumps are Worthington-Simpson standard pattern multi-stage centrifugals, composed of suction and discharge casings and intermediate sections, the whole held together by external bolts extending between the casing and also bolts between neighbouring sections. The eyes of the casings and sections are fitted with renewable rubbing rings. The impellers are of phosphor-bronze, with composition bushes for the shaft between the several stages. An automatic hydraulic balancing device is provided at the high-pressure end in the form of a disc fixed to and revolving with the shaft. Renewable liners of hard phosphor bronze are fitted, and the whole arrangement is outside the main body of the pump and easily accessible. It will be noticed from Fig. 1 that one side of the disc is under delivery pressure, by way of a connection through the inner bearing to the delivery casing, while the other side of the disc is under suction pressure by way of a pipe connection to the pump

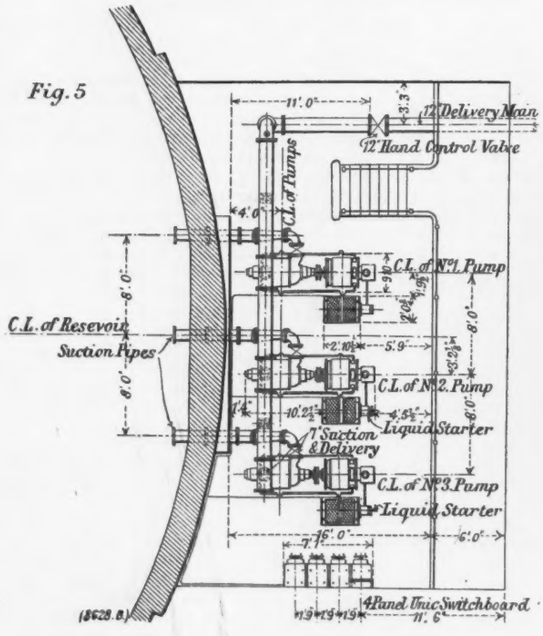
FIRE SERVICE PUMPING INSTALLATION AT THE BRITISH EMPIRE EXHIBITION.



Figs. 1 and 2. 7-in. Multi-Stage High-Lift Centrifugal Pump; Messrs. Worthington-Simpson, Limited.







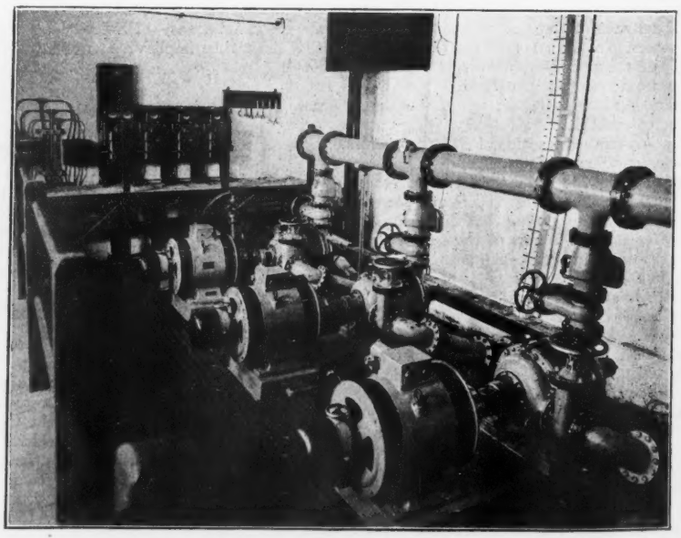


Fig. 6.

Figs. 3 to 6. General Arrangement of Pumping Station.

suction. The stuffing boxes are thus at both ends of the pump exposed only to low pressures. Water seal is provided at the suction stuffing box. The bearings consist of cast-iron bushes lined with white metal and are ring lubricated. The bearings are entirely isolated from the stuffing-boxes.

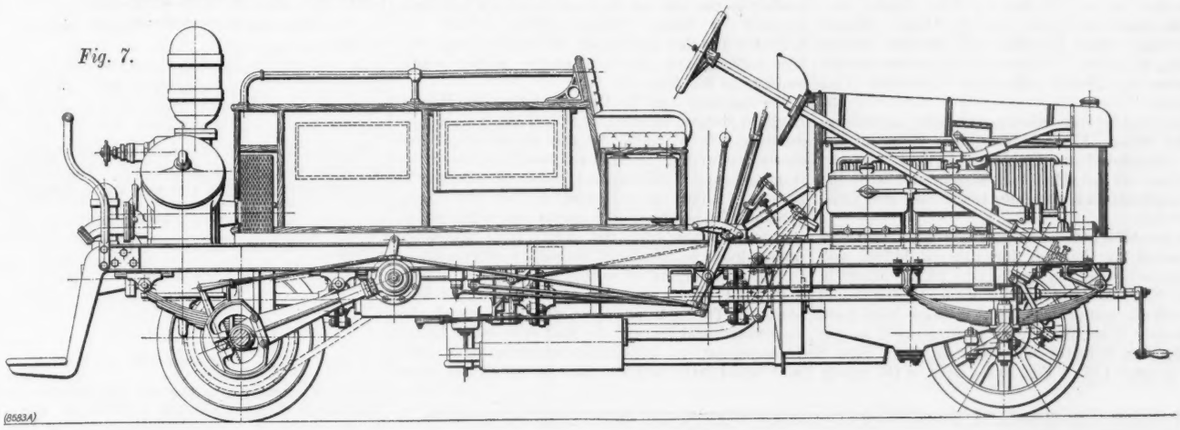
These pumps are direct-connected to induction motors by the English Electric Company, Limited, of Kingsway, London. The coupling is flexible, the power being transmitted through a number of steel pins working in rubber bushes. The motors are of the English Electric Company's standard induction type, with slip-ring rotor fitted with short circuiting and brush-lifting device. Special attention has been paid to the matter of ventilation in this type of motor, in which also a feature of some note is the use of heavy-type roller bearings, and as a consequence there is reduced wear, permanence of air gap concentricity, and a reduction in the lubricating oil required.

Each of the motors driving the pumps is provided with a stator trifurcating box, attached to the side of the terminal enclosure on the top of the stator frame. The starters are of the horizontal shaft liquid type, by means of which resistance is inserted in the rotor circuits at starting and gradually reduced by the immersion of a larger part of the contact plates in the electrolyte, until finally the plates are short circuited. At this stage the brush-lifting and short-circuiting device is operated, thus relieving the slip rings and brushes of unnecessary wear. The supply of current is controlled by means of a compact switchboard of the English Electric Company's ironclad draw-out type. The board is made up of four standard units, each consisting of an oil-immersed circuit-breaker mounted on a sliding carriage, an isolating switch, and bus-bar chamber at the back. One of the units controls the main incoming supply to the bus-bars which run

500-GALLON MOTOR FIRE ENGINE AT THE BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY MESSRS. MERRYWEATHER AND SONS, LIMITED, ENGINEERS, GREENWICH.

Fig. 7.



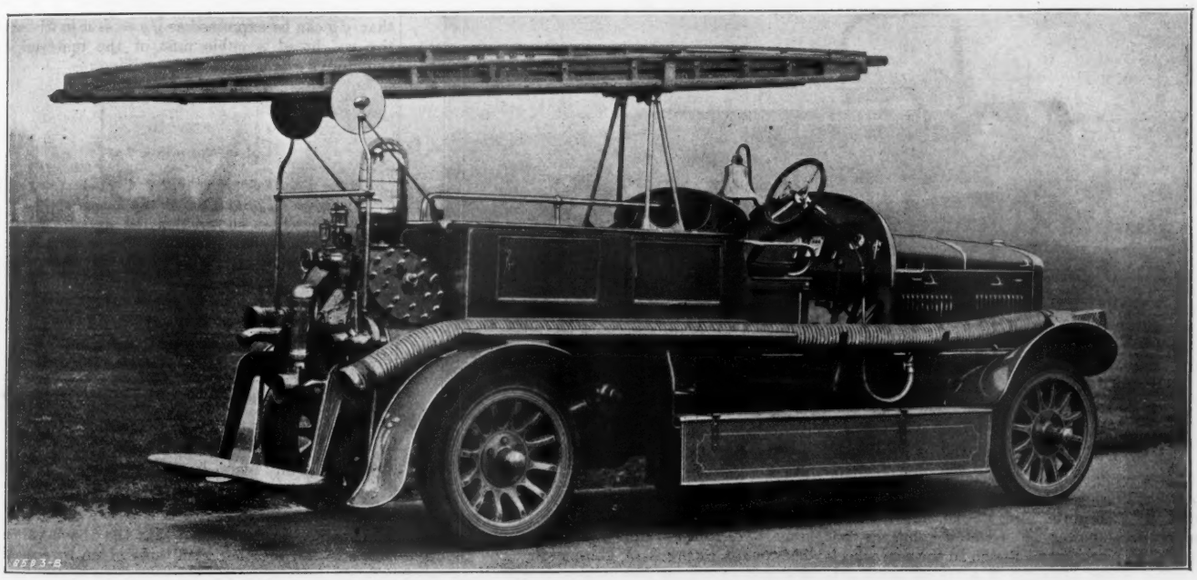


FIG. 8.

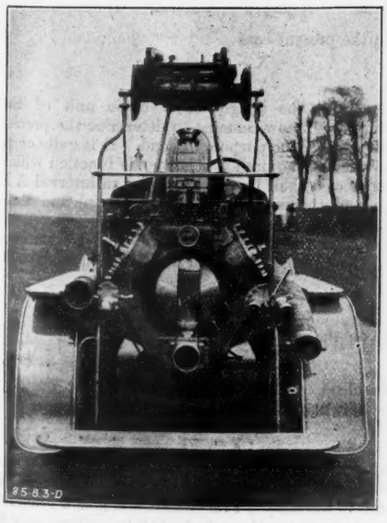


FIG. 9.

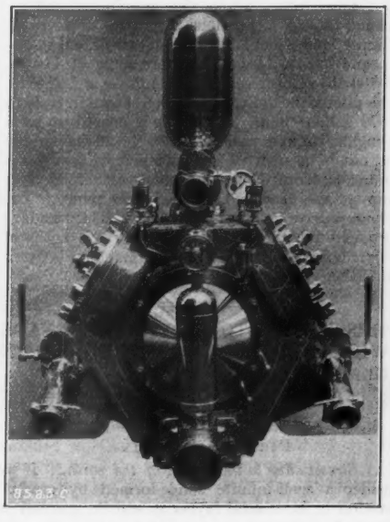


FIG. 10.

along the bus chambers, the other three units controlling the pump motors. Each motor panel is provided with an ammeter and with overload and low voltage releases.

Before dealing with other appliances we may give a few particulars in connection with the general precautions against fire. All wood work, it may be remarked, has been fire-proofed, while stand-holders have to provide their own extincteurs on a scale of one per 1,000 sq. ft. The number of these hand appliances available, amounts to over 3,000. The buildings are regularly patrolled, and a look-out is maintained night and day on one of the Stadium towers. All parts of the grounds are in telephonic communication with fire brigade headquarters, situated near the south-west entrance. Here is the brigade's No. 1 station, a second being situated in the centre of the Amusement Park. The brigade consists of 46 officers and men. Within two minutes of a call, a crew of 6 to 8 men with a motor-pump can reach any point in the grounds. The complete first turn-out strength of 3 motor-pumps and 18 men can be mobilised at any point within five minutes.

The chief units placed at the service of the exhibition authorities consist of three large motor-pumps of about 500 gallons capacity, with ladders, hose carts, &c., and four smaller units, one of which is a

mobile machine, while the others are of the trailer type which is now becoming so deservedly popular.

The larger machines are by Messrs. Merryweather and Sons, Limited, Messrs. Leyland Motors, Limited, and Messrs. Dennis Brothers, Limited. The smaller mobile unit is by the Stanley Fire Engine Co., while the trailer units are again by Messrs. Merryweather and Sons, Limited and Messrs. Dennis Brothers, Limited, the third being a four-wheeled appliance by Messrs. Martin's Cultivator Co., Limited.

Taking first for convenience, the motor engine supplied by Messrs. Merryweather, this is one of the firm's "Hatfield" machines. It is housed at the Exhibition fire brigade headquarters and with the other machines is kept ready for use at any time, day or night.

This machine is the first of a new type, specially constructed by the firm for the exhibition, and can always be seen on application to the officer in charge. The essential features of the original design are retained, and several novel changes have been introduced. The fire engine is illustrated in the drawing, Fig. 7, in the side and rear views, Figs. 8 and 9 on page 155. Fig. 10 is a view of the pump.

Fig. 11. 500-Gallon Motor Fire Engine; Messrs. Leyland Motors, Limited.

The petrol motor has four cylinders, in pairs, 135 mm. in diameter, with a 150 mm. stroke, and develops 65 brake horse-power at 1,150 revolutions per minute. The power transmission to the rear wheels is by roller chain, allowing of a forged steel axle and the maximum ground clearance possible. The pump is of the well-known Merryweather "Hatfield" reciprocating type, and is driven by a silent chain speed-reducing gear from an extension of the first motion shaft through the speed gear-box. It has a capacity of 500 gallons per minute at a pressure of 120 lb. per sq. in., and will deliver four powerful fire jets $\frac{3}{4}$ in. in diameter simultaneously.

A complete "Hatfield" pumping unit of exactly the same type and capacity as that installed on the fire engine can be seen on Messrs. Merryweather's stand. This is the pump which we illustrate in the view, Fig. 10. It is entirely of gun-metal, with copper air vessels, the whole of the metal work, where possible, being burnished to a very high degree of finish.

The essential features of the "Hatfield" pump are three single-acting plungers in cylinders set at 120 deg., and driven by a single crank. The result is an extremely compact design, particularly suitable for fixing in an automobile chassis, and convenient for operation from the motor transmission gear. The pump valves are fixed in a chamber surrounding the plungers in such a manner as to eliminate all possible air space without unduly restricting the passage of water through the barrels, thus allowing of a vacuum of 23 in. to 24 in. to be maintained on a dry pump, an important advantage when the requirements of the fire service call for maximum lifts, without having to prime the suction pipe. The whole of the motion runs in a totally enclosed crank-case with splash lubrication. The mechanical efficiency of the "Hatfield" pump is relatively high, the makers claiming from 80 to 90 per cent.

It is interesting to note that a machine of design similar to the one we illustrate herewith has been supplied by Messrs. Merryweather to H.M. the King for the fire protection of Sandringham, the firm holding the Royal Warrant as fire engine builders to His Majesty.

The machine lent to the exhibition by Messrs. Leyland Motors, Limited, is also of 500 gallon p.m. capacity. It is similar to the motor fire engine illustrated in Fig. 11, annexed, and is of the firm's standard type. The engine fitted to the machine is a four-cylinder motor, rated at 55 h.p. Dual ignition by high tension magneto and accumulator is fitted. Water from the supply from which the pump draws is circulated through a filter and on to the radiator, in order that the engine may be kept cool when pumping at full load for long periods. The gear-box provides four speeds for the chassis, and reverse, the final drive being by the Leyland pattern of double-reduction back axle, with bevel drive to a lay shaft on which the differential is mounted. The last reduction is by spur gears to the driving shafts. The pump is a four-stage Rees-Roturbo unit of the twin-impeller type. The pump casing is of gun-metal. The pump is designed to deliver 550 gallons at 120 lb. pressure per square inch with a lift of 10 ft. It will give a maximum pressure of 200 lb., and has a maximum lift of 27 ft. Against 160 lb. pressure it will deliver 450 gallons p.m., while the maximum output (without lift) is 750 gallons against a pressure of 80 lb. per square inch. Employing two nozzles, one 1 in. and one of $1\frac{1}{8}$ in., with pressures of 110 lb. and 100 lb. respectively at the nozzle and 120 lb. at the pump, the delivery has been shown in tests to be 570 gallons p.m. The pump is geared up from the engine, running at 1·75 times the engine speed; it is out of gear when the machine is travelling. Priming is arranged for by means of a rotary air pump at the rear end of the main pump. The air pump drive is by friction gear. The standard equipment includes two 8 ft. or 10 ft. lengths of suction hose, and the 500 gallon machine is fitted with either two or three delivery branches.

STRESSES DUE TO A LOADED SURFACE WHEN EARTH IS TREATED AS AN ELASTIC SOLID.

By S. D. Carothers, A.M.Inst.C.E., A.R.C.Sc.

(*Concluded from page* 2.)

Part II.—Appendix.

(A) *Stresses due to the weight of the earth.* If we consider a semi-infinite solid formed by gradual accretion in horizontal layers it will be granted at once that in respect to any point within the solid already formed there can be no lateral movement due to further loading. Taking the axis of z along the axis of the loaded strip and y vertically downwards, and remembering that the stresses now under consideration are those due to the weight of the earth only, and are quite independent of the load on the strip, the movements at any point may be written:—

$$\left.\begin{aligned} u = 0,\quad v = a + by + cy^2,\quad w = 0 \\ \Delta = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{dw}{\partial z} \\ = b + 2cy \end{aligned}\right\} \quad . \quad (1)$$

This form of Δ is harmonic and no higher power of y than y^2 can be included in v. The stresses can now be written out by the well known formulæ:—

$$\widehat{xx} = \lambda\,\Delta + 2\mu\frac{du}{dx},\ \&c.$$

giving

$$\left.\begin{aligned} \widehat{xx} &= \lambda(b + 2cy) \\ \widehat{yy} &= (\lambda + 2\mu)(b + 2cy) \\ \widehat{zz} &= \lambda(b + 2cy) \\ \widehat{yz} &= z\widehat{x} = \widehat{xy} = 0 \end{aligned}\right\} \quad . \quad . \quad (2)$$

As the stress $\widehat{yy}$ is the normal pressure on any horizontal plane at a depth y below the surface, it is obvious that it vanishes at $y = 0$ and therefore $b = 0$. From ordinary considerations it is clear that $\widehat{yy}$ can be expressed as $\widehat{yy} = -wy$, where w is the weight of a cubic unit of the material and therefore $2c = -w/(\lambda + 2\mu)$, giving:—

$$\left.\begin{aligned} \widehat{xx} &= -\lambda w y/(\lambda + 2\mu) \\ \widehat{yy} &= -wy \\ \widehat{zz} &= -\lambda w y/(\lambda + 2\mu) \\ \widehat{yz} &= z\widehat{x} = \widehat{xy} = 0 \end{aligned}\right\} \quad . \quad . \quad (3)$$

(B) *Stresses due to a uniformly loaded strip.*

(2) It has been shown that the stresses produced in two dimensional stress systems when the body forces are omitted, can generally be resolved into four distinct types.

Only one of these types will be required in the present investigation, it is:—

$$\left.\begin{aligned} \widehat{xx} &= \phi + y\frac{\partial\phi}{\partial y} \\ \widehat{yy} &= \phi - y\frac{\partial\phi}{\partial y} \\ \widehat{xy} &= -y\frac{\partial\phi}{\partial x} \end{aligned}\right\} \quad . \quad . \quad . \quad (4)$$

where ϕ is any plane harmonic function satisfying

$$\frac{\partial^2\phi}{\partial x^2} + \frac{\partial^2\phi}{\partial y^2} = 0.$$

It can be easily verified that the above values of the stresses, together with those given by equations (3), do, in fact, satisfy the equations of equilibrium

$$\left.\begin{aligned} \frac{\partial}{\partial x}\widehat{xx} + \frac{\partial}{\partial y}\widehat{xy} + \rho X = 0 \\ \frac{\partial}{\partial x}\widehat{xy} + \frac{\partial}{\partial y}\widehat{yy} + \rho Y = 0 \end{aligned}\right\} \quad . \quad . \quad (5)$$

In the present case

$$X = 0,\ \text{and}\ Y = g,$$

and

$$\rho Y = w$$

where w is the weight of a cubic unit of the material. It now remains to determine the precise value of ϕ for the purpose in hand. It is quite clear that what is required is a harmonic function which when $y = 0$ shall be constant over an interval A B (equal to the width of the loaded strip) and shall vanish outside this interval.

Consider the scheme of stresses under equations (4). The normal stress on any horizontal plane is

$$\widehat{yy} = \phi - y\frac{\partial\phi}{\partial y} \quad . \quad . \quad . \quad . \quad (6)$$

and on the plane $y = 0$ this becomes

$$\widehat{yy} = \phi \quad . \quad . \quad . \quad . \quad (7)$$

The shear on any horizontal plane or on any vertical plane is

$$\widehat{xy} = -y\frac{\partial\phi}{\partial x} \quad . \quad . \quad . \quad (8)$$

and this vanishes on the plane $y = 0$.

There is thus obtained on the plane $y = 0$ normal stress of intensity ϕ everywhere, and it now remains to select a value of ϕ which shall be uniform over a

given width of strip and vanish at all points on the surface outside this strip. Further ϕ must remain finite, continuous and one-valued at all points within the solid and vanish at infinity everywhere.

Suppose the width of the strip is denoted by AOB, AB = $2a$ being bisected in O, the axes being taken as shown in Fig. 3.

Consider the angle A Q B = α subtended by AB at any point Q in the solid. If Q approaches any point in the surface $y = 0$ outside AB, such as the point C or D, then α approaches zero, but if Q approaches any point between A and B then α approaches 180 deg, or in circular measure α approaches π, and it is in circular measure that all the angles will be measured. Now we have in α a function which is finite, continuous and one valued throughout the whole of the solid, is equal to π over the interval AB, and is equal to zero over the remainder of the surface. Now α would be of no service for the purpose in hand unless it were harmonic, and this it fortunately is, for it satisfies the equation

$$\frac{\partial^2 \alpha}{\partial x^2} + \frac{\partial^2 \alpha}{\partial y^2} = 0 \quad . \quad . \quad . \quad (9)$$

at every point of the solid, and, in addition, it vanishes at infinity over the whole boundary of the solid. It, therefore, satisfies all the requisite conditions.

If the pressure over AB is P units per square foot of surface, the stresses may now be written, by the aid of equations (4), as follows :—

$$\left.\begin{aligned} \widehat{xx} &= -\frac{P}{\pi}\left(\alpha + y\frac{\partial \alpha}{\partial y}\right) \\ \widehat{yy} &= -\frac{P}{\pi}\left(\alpha - y\frac{\partial \alpha}{\partial y}\right) \\ \widehat{xy} &= -\frac{P}{\pi}\left(\quad - y\frac{\partial \alpha}{\partial x}\right) \end{aligned}\right\} \quad . \quad . \quad (10)$$

The normal pressure over the plane $y = 0$ for all points between A and B is

$$\widehat{yy} = -\frac{P}{\pi}\alpha = -P \quad . \quad . \quad (11)$$

while for all points outside AB

$$\widehat{yy} = 0,$$

and

$$\widehat{xy} = 0$$

everywhere on $y = o$.

(3) To enable the various equations to be calculated it will be convenient to set out the values of α, $\frac{\partial \alpha}{\partial x}$, $\frac{\partial \alpha}{\partial y}$, &c., in terms of the co-ordinates of any point. (Fig. 4.)

Referring to the figure,

Let O be the origin, O A = O B = a, A Q = r_1, B Q = r_2.

Let Q C be the bisector of the angle A Q B = α.

Let $\angle$ Q A N = α_1, $\angle$ Q B N = α_2, $\angle$ Q C N = θ, $\angle$ C Q N = ϕ.

It is easily seen that :

$$2\theta = \alpha_2 + \alpha_1 \text{ and } a = \alpha_2 - \alpha_1.$$

Again

$$\alpha = \angle \text{ A Q N} - \angle \text{ B Q N}.$$

$$= \tan^{-1}\frac{x+a}{y} - \tan^{-1}\frac{x-a}{y} \quad . \quad (12)$$

and

$$\frac{\partial \alpha}{\partial y} = -\frac{x+a}{(x+a)^2+y^2} + \frac{x-a}{(x-a)^2+y^2},$$

$$= -\frac{x+a}{r_1^2} + \frac{x-a}{r_2^2} \quad . \quad . \quad . \quad (12a)$$

Similarly

$$\frac{\partial \alpha}{\partial x} = \frac{y}{r_1^2} - \frac{y}{r_2^2} \quad . \quad . \quad . \quad . \quad . \quad (12b)$$

From 12a it easily follows that

$$y\frac{\partial \alpha}{\partial y} = \tfrac{1}{2}[\sin 2\alpha_2 - \sin 2\alpha_1] \quad . \quad . \quad . \quad (13)$$

$$= \sin a \cos(\alpha_2 + \alpha_1) \quad . \quad (13a)$$

$$= \sin a \cos 2\theta \quad . \quad . \quad . \quad . \quad . \quad (13b)$$

$$= -\sin a \cos 2\phi, \quad . \quad (13c)$$

The principal stresses are, by a well-known theorem, given by

$$p_{1,2} = \frac{\widehat{xx} + \widehat{yy}}{2} \pm \frac{\sqrt{(\widehat{xx} - \widehat{yy})^2 + (2\widehat{xy})^2}}{2} \quad (14)$$

$$\tan 2\theta_1 = 2\widehat{xy} / (\widehat{xx} - \widehat{yy})$$

where p_1 and p_2 are the principal stresses and θ_1 is the inclination of one of the stresses to the axis of x. There is thus obtained from equations (10)

$$p_1 = P\left(a + y\sqrt{\left(\frac{\partial a}{\partial x}\right)^2 + \left(\frac{\partial a}{\partial y}\right)^2}\right)/\pi$$

$$p_2 = P\left(a - y\sqrt{\left(\frac{\partial a}{\partial x}\right)^2 + \left(\frac{\partial a}{\partial y}\right)^2}\right)/\pi \quad . \quad (15)$$

It is easily seen from equations (12a) and (12b) that

$$\left(\frac{\partial a}{\partial x}\right)^2 + \left(\frac{\partial a}{\partial y}\right)^2 = \frac{4a^2}{r_1^2 r_2^2}$$

where $r_1^2 = (x+a)^2 + y^2$, $r_2^2 = (x-a)^2 + y^2$,

and therefore

$$y\sqrt{\left(\frac{\partial a}{\partial x}\right)^2 + \left(\frac{\partial a}{\partial y}\right)^2} = \frac{2ay}{r_1 r_2} = \sin a \quad . \quad (16)$$

and thus

$$p_1 = P(a + \sin a)/\pi \quad . \quad . \quad . \quad (17)$$

$$p_2 = P(a - \sin a)/\pi$$

Fig. 3.

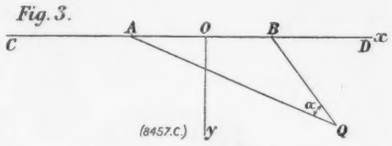


Fig. 4.

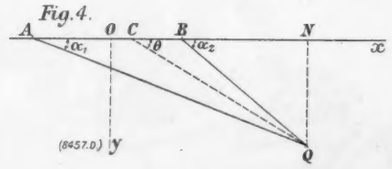


Fig. 5.

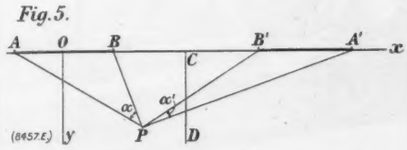


Fig. 6.

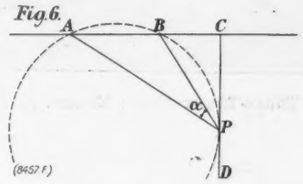
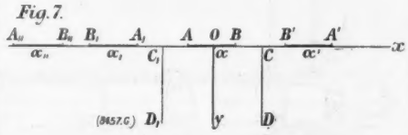


Fig. 7.



Again, from equations (10) and (14)

$$\tan 2\theta_1 = -\frac{\partial a}{\partial x} \Big/ \frac{\partial a}{\partial y}$$

$$= 2xy/(x^2 - y^2 - a^2)$$

$$= \tan(\alpha_1 + \alpha_2)$$

$$= \tan 2\theta$$

$$\therefore \quad \theta = \theta_1 = \tfrac{1}{2}(\alpha_1 + \alpha_2)$$

and thus the direction of the principal stress p_1 bisects the angle α at every point.

(4) Suppose now that a smooth vertical wall is placed at CD as shown in Fig. 5.

The normal pressure on CD would only be correctly denoted by equations (10) if CD moved at every point in the same way as if it were a part of the original solid. If it is smooth and inflexible, the pressures will be greatly modified and these can be obtained in the following manner.

Consider another load of intensity P placed over A′B′ the image of AB in the plane CD.

The surface CD under the influence of the two loads would remain plane. The movement in the horizontal direction would become zero at CD and the movement in the vertical direction would be doubled at CD and it may be assumed, for the moment, that the barrier CD is removed.

The stresses at any point P (Fig. 4) under the influence of the two loaded strips are:

$$\left.\begin{aligned} \widehat{xx} &= -\frac{P}{\pi}\left\{(\alpha + \alpha^1) + y\frac{\partial}{\partial y}(\alpha + \alpha^1)\right\} \\ \widehat{yy} &= -\frac{P}{\pi}\left\{(\alpha + \alpha^1) - y\frac{\partial}{\partial y}(\alpha + \alpha^1)\right\} \\ \widehat{xy} &= -\frac{P}{\pi}\left\{\quad - y\frac{\partial}{\partial x}(\alpha + \alpha^1)\right\} \end{aligned}\right\} . \quad (19)$$

where α and α' are the angles subtended at the point by the lines AB and A′B′ respectively.

Now since AB and A′B′ are symmetrically placed with reference to the plane CD it is obvious that for any point on CD, $\alpha = \alpha'$ and that $\frac{\partial \alpha}{\partial y} = \frac{\partial \alpha^1}{\partial y}$, also $\frac{\partial}{\partial x}(\alpha + \alpha') = 0$, seeing that as x increases through CD, α diminishes at the same rate that α' increases.

The pressure at the plane CD can thus be written

$$\left.\begin{aligned} \widehat{xx} &= -2P\left(\alpha + y\frac{\partial \alpha}{\partial y}\right)/\pi \\ \widehat{yy} &= -2P\left(\alpha - y\frac{\partial \alpha}{\partial y}\right)/\pi \\ \widehat{xy} &= \text{zero.} \end{aligned}\right\} \quad . \quad . \quad (20)$$

and these are the pressures which would be exerted against a smooth vertical inflexible wall placed at CD due to a uniform load P per unit area placed on AB only.

The pressure normal to the wall is

$$\widehat{xx} = -2P\left(\alpha + y\frac{\partial \alpha}{\partial y}\right)/\pi \quad . \quad . \quad (21)$$

and as both terms within the brackets vanish when $y = 0$ the pressure at the surface is zero for values of x outside the limits $\pm a$.

It is not difficult to show that for a given value of x, outside the limits $\pm a$, $\widehat{xx}$ is a maximum for that value of y given by the equation

$$y^2 = \left[2x(x^2 - a^2)^{\frac{1}{2}} - (x^2 - a^2)^2\right]/(3x^2 + a^2) \quad . \quad (22)$$

It is easily seen that the point where α is a maximum is the point of contact (P) of the circle which touches CD and passes through the points A and B (Fig. 6). As α is constant over the whole of this circle, it is clear that at the point P the value of $\partial\alpha/\partial y$ = zero, giving at this point,

$$\widehat{xx} = -2P\alpha/\pi \quad . \quad . \quad . \quad . \quad (23)$$

(5) Suppose now that the plane CD is brought up to the point B, the angle $\alpha = \pi/2$ when $y = o$ and the pressure now becomes a maximum at the surface and falls off as y increases.

At the surface $y = 0$

$$\widehat{xx} = -P \quad . \quad . \quad . \quad . \quad (24)$$

and these equations, being all independent of the elastic constants of the body, must be correct over a very wide range of materials.

(6) Again suppose that a barrier similar to CD is placed at C_1D_1 (Fig. 7) the other side of AB, and that $OC = OC_1$. The two loads AB and A^1B^1 would still retain the surface CD plane but the surface C_1D_1 would become distorted. To remove the distortion from the latter, two further loads A_1B_1 and $A_{11}B_{11}$ the images of the former in the plane C_1D_1 would be required, but now the plane CD is distorted and thus an infinite number of images are required to remove the distortion from the two planes CD and C_1D_1 and the stresses at any point within the area CDD_1C_1 are simply

$$\left.\begin{aligned} \widehat{xx} &= -\frac{P}{\pi}\left\{a + a^1 + a_1 + a^{11} + a_{11} + \right. \\ &\qquad \left. + y\frac{\partial}{\partial y}(a + a^1 + a_1 +)\right\} \\ \widehat{yy} &= -\frac{P}{\pi}\left\{a + a^1 + a_1 + a^{11} + a_{11} + \right. \\ &\qquad \left. - y\frac{\partial}{\partial y}(a + a^1 + a_1 +)\right\} \\ \widehat{xy} &= -\frac{P}{\pi}\left\{\quad - y\frac{\partial}{\partial x}(a + a^1 + a_1 +)\right\} \end{aligned}\right\} \quad (25)$$

and there is no difficulty whatever in solving these equations for any given case graphically or analytically.

(7) Suppose the barriers CD and C_1D_1 are moved up to B and A, respectively, the various images become continuous, and the result, so far as the region CDD_1C_1 is concerned, is equivalent to a

THE COLLIERY AT THE BRITISH EMPIRE EXHIBITION.

(*For Description, see Page* 159.)

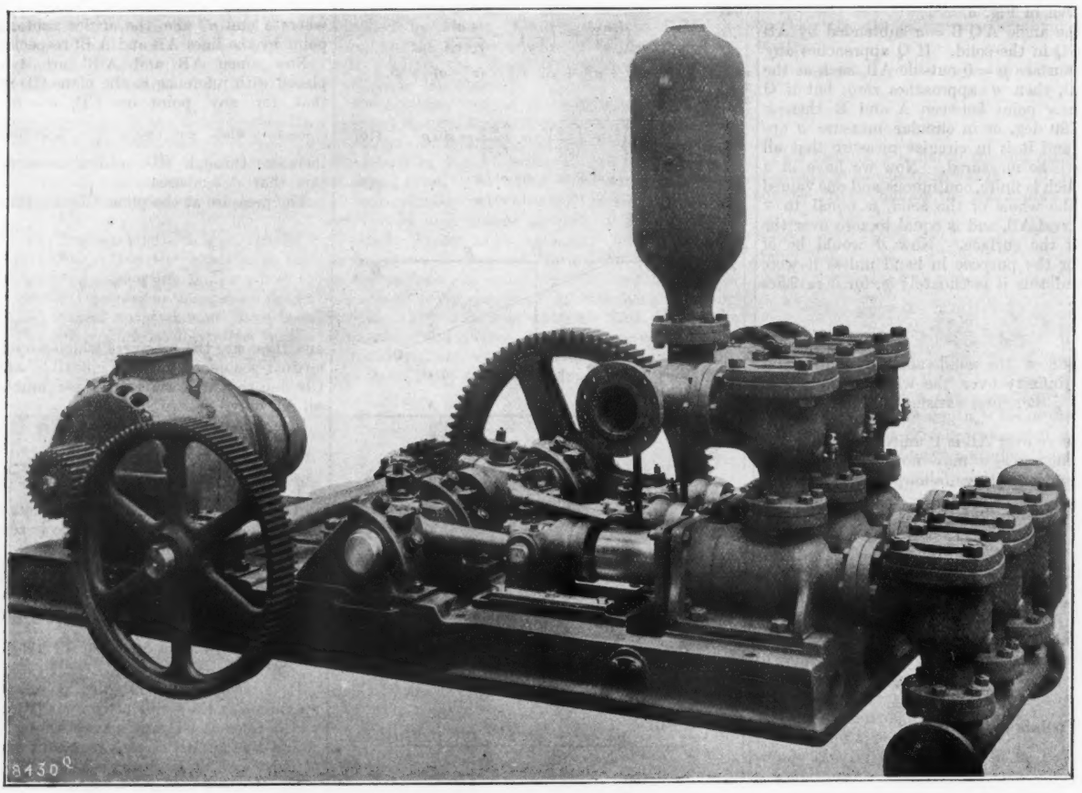


Fig. 79. Motor-Driven Three-Throw Pump; Messrs. F. Pearn and Co., Limited.

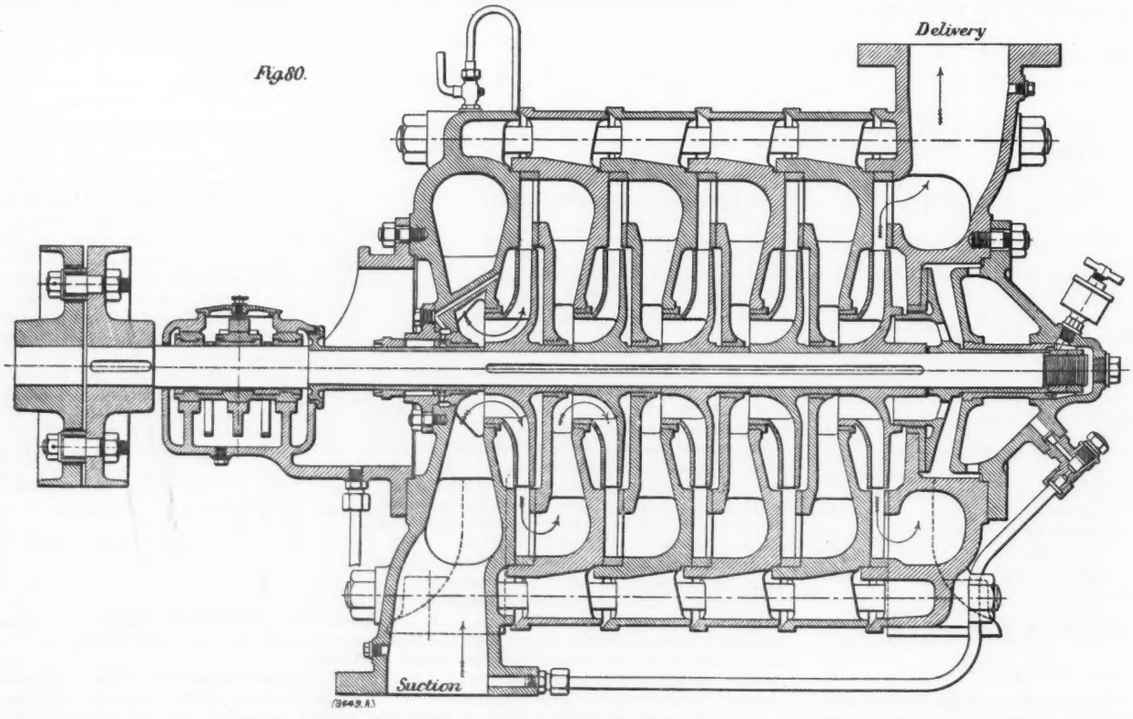


Fig. 80. Multi-Stage Turbine Pump; Messrs. Holden and Brooke, Limited.

THE COLLIERY; EMPIRE EXHIBITION.

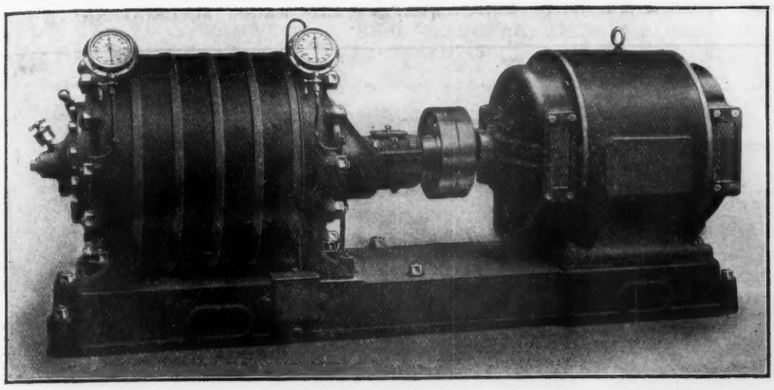
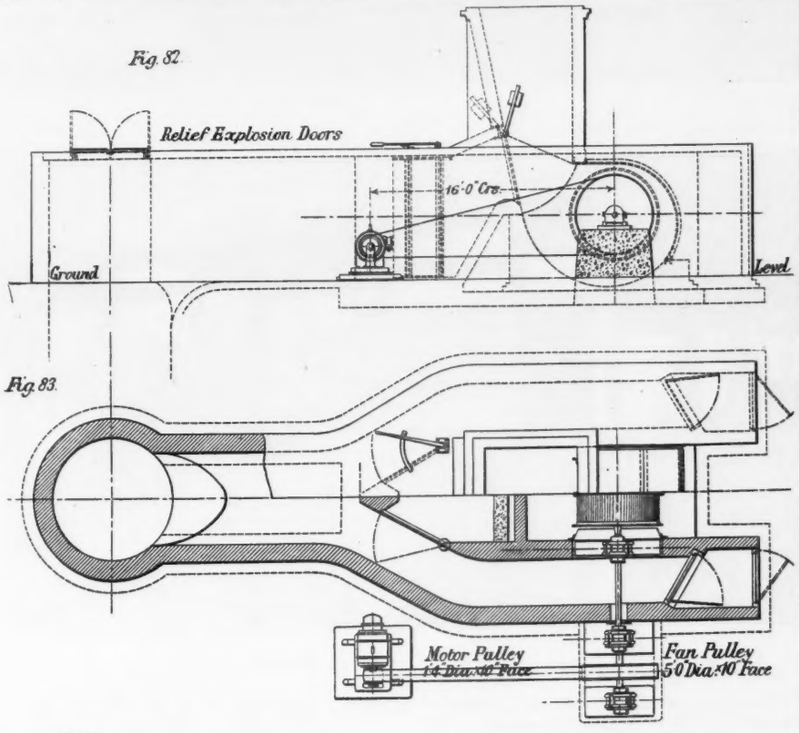
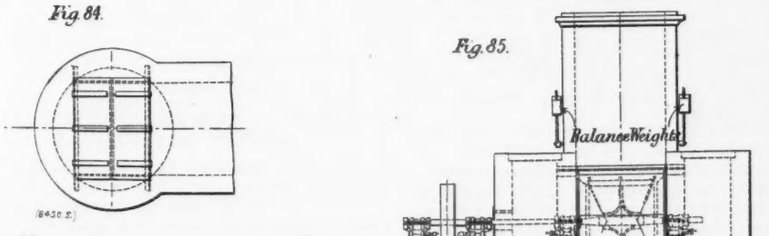


FIG. 81. ELECTRICALLY-DRIVEN TURBINE PUMP; MESSRS. HOLDEN AND BROOKE, LIMITED.





FIGS. 82 TO 85. VENTILATING PLANT; MESSRS. DAVIDSON AND CO., LIMITED.

uniform load P per unit surface extending to infinity giving :—

$$\widehat{xx} = \widehat{yy} = -\mathrm{P} \text{ and } \widehat{xy} = 0$$

everywhere between the two barriers.

(8) From the third of equations (10) the shear at any point is $\frac{P}{\pi} y \frac{\partial}{\partial x}$ which by (12*b*) becomes $\frac{P}{\pi}\left(\frac{y^2}{r_1^2} - \frac{y^2}{r_2^2}\right)$. Now consider any point on the plane $x = a$, *i.e.*, the vertical plane under the edge B of the loaded strip. It is seen at once that $y^2/r_1^2 = o$ when $y = o$ and $r_1 = 2a$, also $y^2/r_1^2 =$ unity when $y = \infty$ and thus y^2/r_1^2 varies from zero to unity as y increases from zero to infinity. Similarly for any point in the same plane $y = r_2$ and y^2/r_2^2 is equal to unity for all values of y however large or small. It will thus be seen that for the plane $x = a$, $\frac{y^2}{r_1^2} - \frac{y^2}{r_2^2}$ varies from -1 to zero as y increases from zero to infinity and therefore the shear on this plane varies from $\widehat{xy} = -\mathrm{P}/\pi$ at $y = o$ to $\widehat{xy} = o$ at $y = \infty$. The proof that the shear on the plane $y = o$ is absolutely zero throughout, including the points A and B, will be left to the reader.

THE COLLIERY AT THE BRITISH EMPIRE EXHIBITION.

(*Continued from page* 51.)

AMONGST the chief preoccupations of the colliery engineer are, getting water up out of the workings and bringing air down to them for ventilation. Two examples of modern pumping machinery are shown below ground at the Exhibition Colliery : one is a combined horizontal three-throw pump and motor, manufactured by Messrs. F. Pearn and Co., Limited, of West Gorton, Manchester, and illustrated in Fig. 79. The pump barrels are of cast iron, 7 in. diameter by 9 in. stroke, and the rams are also of cast iron, working through gun-metal neck rings and cast-iron glands. The pump speed is 55 revolutions per minute, and the capacity is 11,000 gallons per hour, against a head of 600 ft., allowing 8 per cent. for slip. Each valve box has a separate door and is fitted with an air cock. The valves are of gun-metal of the mitre type, and the delivery pipe is 6 in. diameter. The pump, with the intermediate shaft of the double reduction gear and the motor, is arranged on one bed-plate. The gears are machine cut, of cast iron, except the motor pinion, which is of compressed paper. The motor supplied by the General Electric Company, Limited, is a 45 h.p. three-phase, Witton slip-ring motor, constructed for 440 volts, 50-cycle current, running at 720 revolutions per minute, of the type specially recommended for use in fiery mines. A G.E.C. draw-out, mining-type pillar, and flame-proof rotor starter for controlling the motor are provided in the equipment.

The other pump is a multi-stage, motor-driven, centrifugal or turbine pump, constructed by Messrs. Holden and Brooke, Limited, of West Gorton, Manchester, capable of delivering 36,000 gallons per hour against a total head of 560 ft., at a speed of 1,450 revolutions per minute, and with an efficiency of 72 per cent. The pump is direct driven by a 170 h.p. electric motor, using the three-phase, 440-volt, 50-cycle current. The horse-power provides for an overload of 20 per cent., the power transmitted at the coupling at the normal duty of the pump being 141·5 h.p. The general design of the pump is shown in the sectional drawing of a five-stage pump of the "Sirius" type (Fig. 80). The construction is on the multiple unit system, which enables a pump to be built up of the requisite number of stages for the work by adding to the number of bodies and impellers and suitably lengthening the shaft and main bolts. This arrangement has the advantage that a faulty joint between the bodies is at once detected by visible leakage of water, whereas in a pump in which the middle bodies are fitted in a single outer casing, leakage may take place undetected. In order to ensure true running the impellers are balanced individually in the first instance and then collectively on the shaft before assembly in place. Each set of guide passages is cast as a complete ring entirely separate from the pump body, which allows the surfaces to be worked smooth, and gives greater efficiency. The bodies have large water passages, and in order to facilitate repair, are fitted with renewable rings where liable to wear caused by the running of the impellers. The stuffing box on the suction cover is of the water-sealed type, fed from the periphery of the first impeller so as to be free from grit when dirty water is being pumped. A special device is fitted to the suction end bearing, which acts as a combined oil and water thrower; it prevents oil from getting out of the bearing and water from getting in while the pump is running, should the housing become flooded in consequence of a stoppage in the drainage pipe. The delivery end bearing is of an internal type, dispensing with a stuffing-box working under heavy pressure and retaining the advantages of an external bearing; it is made with a renewable bush, outside which the

L.M.S. RAILWAY THIRD-CLASS VESTIBULE CAR; BRITISH EMPIRE EXHIBITION.

CONSTRUCTED AT THE COMPANY'S DERBY WORKS; MR. R. W. REID, CARRIAGE AND WAGON SUPERINTENDENT.

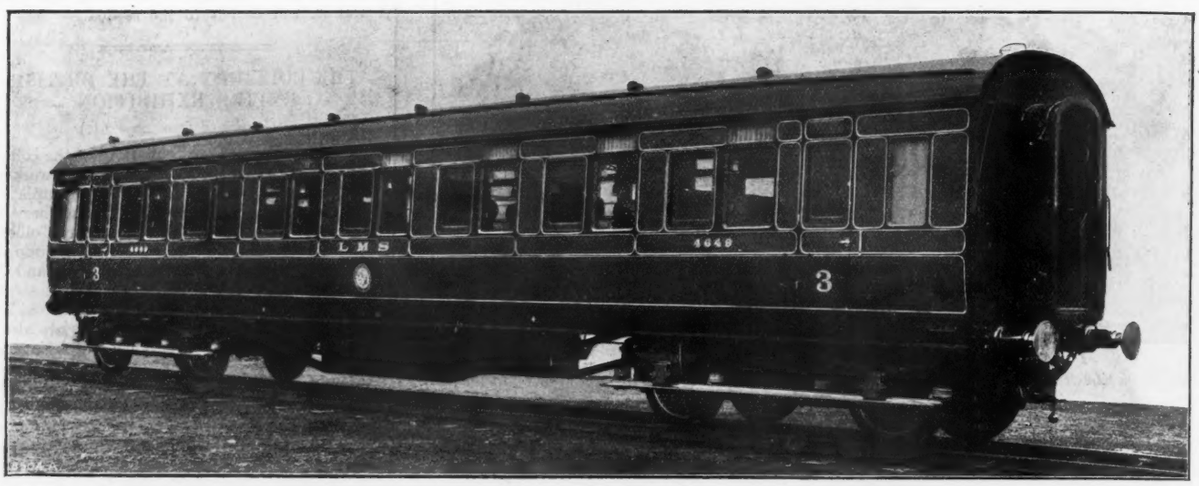


Fig. 86.

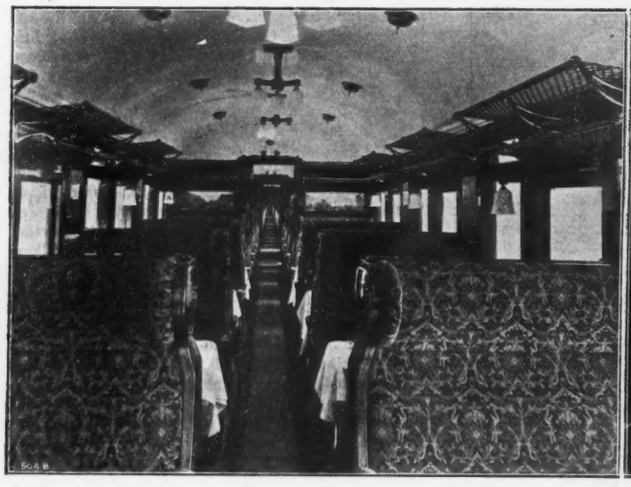


Fig. 87.

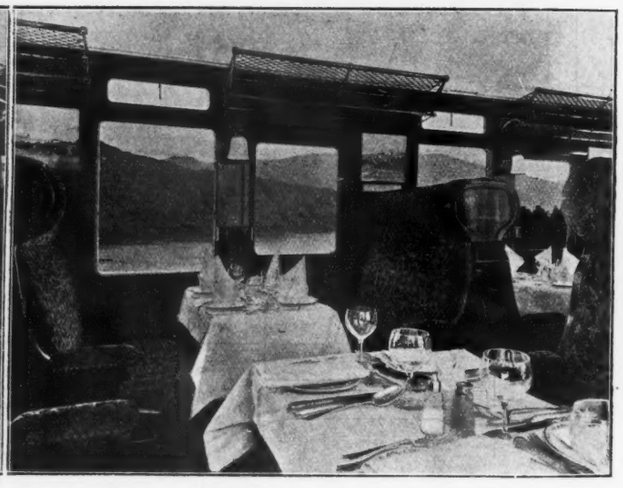


Fig. 88.

water passes for balancing the end thrust of the impellers. Any lubricant working through the bearing passes to the drain, and does not become mixed with the water going through the pump. The arrangement enables the overall length of the pump to be kept down to a minimum.

The end-thrust in a horizontal pump, and in a vertical pump the weight also of the impellers and shaft, is balanced hydraulically, no thrust bearing being required. It is claimed for the turbine pump that it has several advantages over the reciprocating pump: low first cost, small floor space occupied, small cost of foundations, light weight, small running costs, flexibility in working, noiselessness, small cost of maintenance, and facility for direct coupling to an electric motor. In comparing the two pump exhibits, it is to be noted that though considerably smaller and occupying much less floor space, the turbine pump can deliver, to nearly the same height, more than three times the quantity pumped by the reciprocating pump. A general view of the pump is given in Fig. 81 on page 159.

The ventilation of the Exhibition colliery is effected by a "Sirocco" mine fan with connections to the upcast shaft and discharge chimney (Figs. 82 to 85, page 159), constructed by Messrs. Davidson and Company, Limited, Belfast.

This fan is 63 in. diameter, 50 in. wide, of the double inlet type, capable of exhausting 110,000 cub. ft. of air per minute against a pressure of 6 in. water gauge. Owing to the shortness of the workings at Wembley, the fan can only be run at a small fraction of its capacity, in order that the velocity of the air current may not get beyond comfortable limits.

The design of "Sirocco" fans has been based on the principle of running a fan of small diameter at a comparatively high speed of rotation, so that it is in many cases possible to instal direct-coupled sets driven by high-speed engines or high efficiency motors. An advantage of the use of high-speed, small-diameter fans is the substantial reduction in capital cost, due to the small amount of brickwork required in the construction of the discharge chimney and inlets to the fan.

The legislation that requires any system of mine ventilation to be capable of reversal of the direction of flow has been a factor in the selection of fans of this type for the ventilation of collieries. Although the fan is designed essentially to work as an exhauster, it is fitted with an arrangement by means of which the air current underground can be reversed by converting the fan into a blower. This merely involves the manipulation of dampers and doors in the fan chamber, which cut off the discharge chimney and force the fan to blow down the upcast shaft while taking its air supply from the atmosphere. The change-over can be effected in a few minutes, and the direction of rotation of the fan wheel does not require to be reversed.

BRITISH EMPIRE EXHIBITION; RAILWAY MATERIAL.—V.

The chief exhibit of the London, Midland and Scottish Railway is a very fine example of the class of accommodation nowadays provided on the British systems for third-class passengers. The car is a standard third-class vestibule vehicle for main line working on most of the fast trains from Euston and St. Pancras, and is constructed so as to be employed, as necessary, for the service of meals, when attached to a dining car. It is one of an order of 65 vehicles recently put through the railway company's shops at Derby, having been constructed on the mass production system of which we gave a full description in our issue of October 12 last.* The article in question, if referred to, will be found to give a good deal of information on the type of construction as well as the method of organisation and erection, the actual building time in

* See Engineering, vol. cxvi, page 466.

BOGIE FOR L.M.S. RAILWAY CAR AT THE BRITISH EMPIRE EXHIBITION.

MR. R. W. REID, M.I.MECH.E., CARRIAGE AND WAGON SUPERINTENDENT.

Fig. 107.

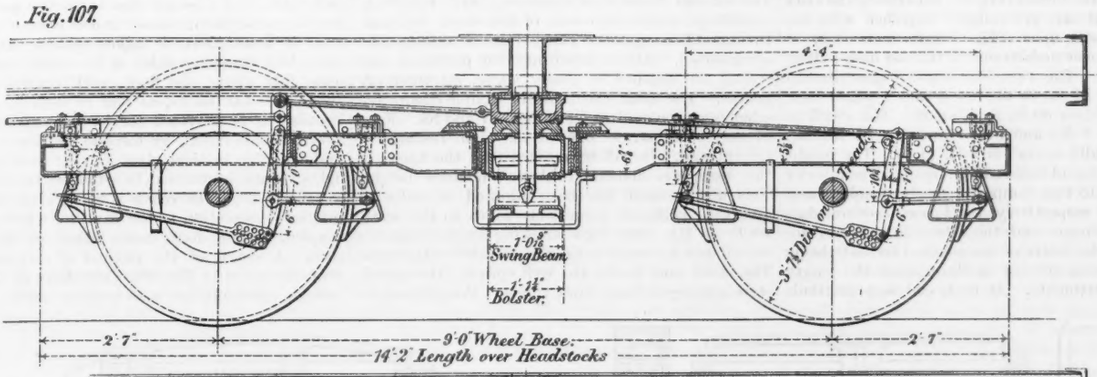


Fig. 108.

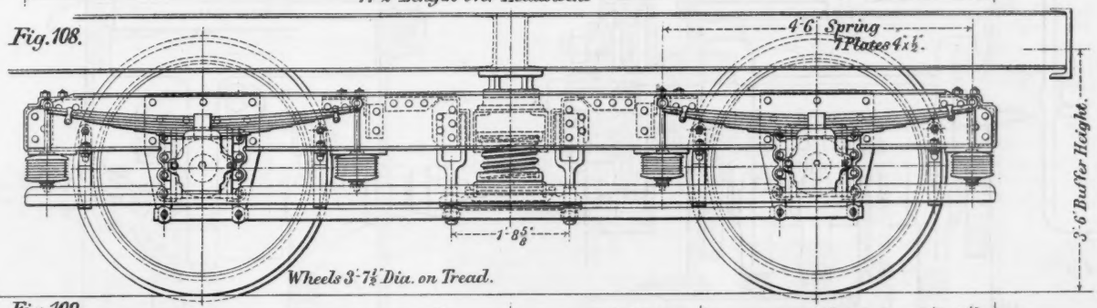


Fig. 109.

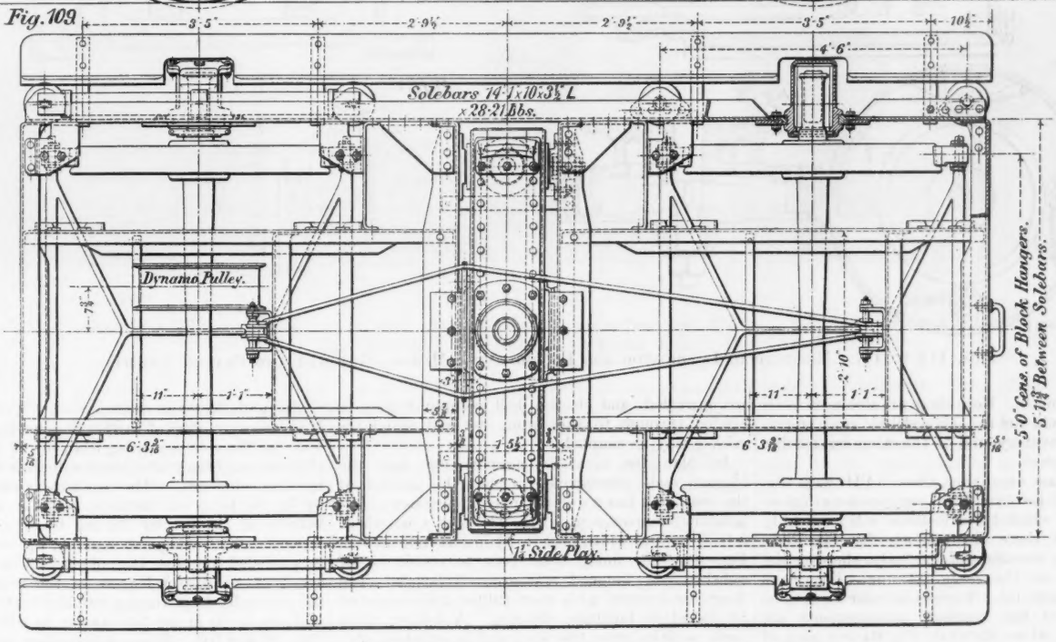


Fig. 110.

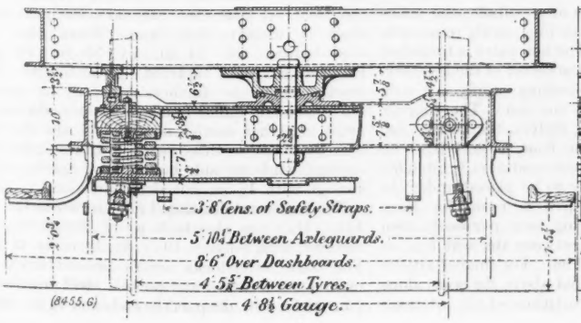


Fig. 111.

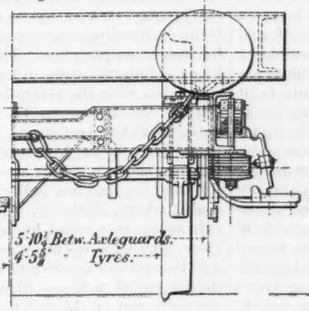
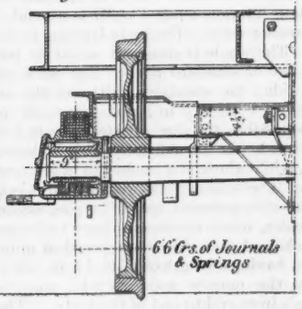


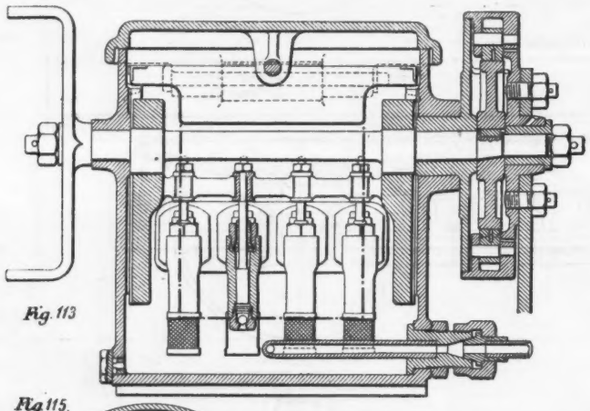
Fig. 112.

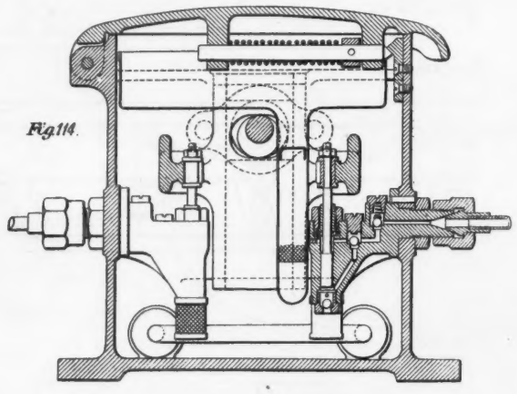


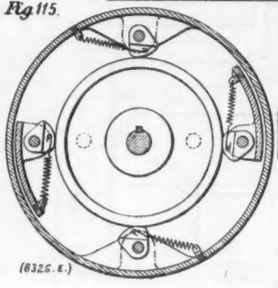
the shops having been reduced by the means adopted to six days.

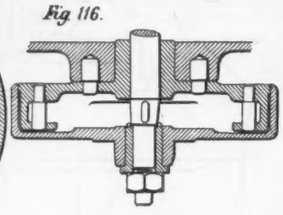
The coach is illustrated in Figs. 86, page 160, which gives an exterior view, and Figs. 87 and 88 shows the interior, the former (Fig. 87) illustrating the vista when several cars are coupled together with the gangway doors open. The length over body is 57 ft. 1 in., over underframe 57 ft., and over buffers 60 ft. 8 in. The two four-wheel bogies having wheels 3 ft. 7½ in. in diameter, and a wheel base 9 ft., are centred 40 ft. 6 in. apart. The width at the waist is 9 ft., and over cornices 8 ft. 10¼ in., while the width overall is 9 ft. 1½ in. The height from rail to top of roof is 12 ft. 5½ in. The interior is divided into two compartments for smokers and non-smokers respectively, the former accommodating 32 passengers and the latter 24. A corridor runs down the centre of the coach, two seats being placed on each side of it throughout the length of the compartments. At each end is a vestibule panelling is of mahogany. The ends are sheeted with vertical tongued- and grooved-jointed boards. Considerable use is made in the body framing of 6-in. by 6-in. by $\frac{3}{16}$-in. pressed steel knees and brackets. The interior finish is in mahogany, with panelling, mouldings, cornice and seats of this wood, polished. In some of the quarter panels framed photographs are inserted. Above the cornice the partitions and ceiling are finished in glossy white, on three-ply veneer. The neat effect of the simple decorative scheme will be evident from Figs. 87 and 88. Figs. 87 and 96 illustrate one of the main features of the interior. It will be noticed that the backs of the seats are narrowed above shoulder height. This arrangement has been adopted in order to give the maximum permissible width to the seats, while at the same time allowing ample room for attendants to move down the corridor with trays. The seats and backs are well sprung, the upholstering being of fawn York velvet. Portable tables

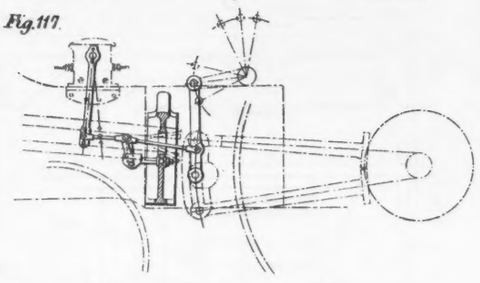
The car is lighted by electricity, the lamps, with square shades of opal glass, being arranged in clusters of three (Fig. 87) down the centre of the ceiling. Single lamps in addition are placed over each table, with a switch close to the bell push. All interior metal fittings are of bronze finish. Heating is on the atmospheric or vapour system, the heaters being laid along the sides of the coach under the seats just above the floor, with control handles above the seat backs, as will be seen in Fig. 95. Ventilation is provided for by drop windows to alternate side lights, by torpedo ventilators in the roof, and by vertical glass louvres over the side lights. These louvres can be set either to exhaust, or to take in air. The coach is fitted with collapsible gangway connection to the cars to which may be coupled, sliding doors being fitted in the coach ends. A detail of the method of carrying these doors is shown in Fig. 98. The doors in the three interior partitions are also made to slide.











Figs. 113 to 117. Mechanical Lubricator for Locomotives; Messrs. Gresham and Craven, Limited.

6 ft. $\frac{3}{16}$ in. in length. Here there are doors on both sides of the coach, and in each vestibule is arranged, on one side a lavatory, and on the other serviceable shelves for luggage.

In our two-page engraving, Plate XVII, with this week's issue of Engineering, we give drawings of this vehicle in which these features will be readily recognised. Of these illustrations, Fig. 89, Plate XVII, gives an elevation of the body, showing the chief features of the body framing. Fig. 90 is a plan of the interior. Various interior elevations and sections of the vestibule arrangements are shown in Figs. 91 to 93, while Fig. 94 is a plan of one of the vestibules. Figs. 95 and 96 show a longitudinal elevation and cross-section of part of the main interior, while Fig. 97 is an end elevation to a smaller scale. The body framing is of oak and teak. The whole is designed as far as possible to make use of standard parts. The main pillars are 3 in. wide; the standard width for the side light frames is 1 ft. 11½ in., and these are placed as far as possible to give quarter panels 1 ft. 2¾ in. wide inside the mouldings. This is done in seven cases, while there is a somewhat wider one in the centre. The treatment between windows is uniform; Special arrangements are, of course, needed at the vestibules, where doors, &c., have to be worked in. The whole of each side is composed of units, two of which, having a length of 12 ft. 7$\frac{7}{16}$ in., are identical. Below the narrow waist panels, one long panel extends from end to end of the body. The outside are provided, and electric bell communication is carried through to the dining car with which the vehicle may be coupled.

In plan the lavatory compartment and the luggage racks correspond, so that the interior of the vestibules has a well-arranged appearance. The lavatory compartments, Fig. 93, have a length of 3 ft. 8 in. and width of 2 ft. 8$\frac{5}{8}$ in., as indicated in Fig. 94. The lining from floor to cornice is of polished oak tongued and grooved boards. The floors are covered with sheet rubber and are coved all round to facilitate cleaning. A folding wash basin is fitted over the w.c., and is supplied with hot and cold water. The water supply is carried for each lavatory in a 35-gallon tank, housed above the luggage rack in the same vestibule, the tanks being enclosed by veneer panelling, easily removable for inspection purposes. The hot water is furnished by an automatic heater in the corner of the lavatory, connected with the steam-heating supply. A cock enables the heater to be cut out. The luggage racks consist of two strong shelves, the bottom one being 2 ft. 4½ in. from the floor, with 1 ft. 7 in. between the two. This accommodation is intended for hand luggage too bulky to be placed under the seats, where, however, there is room for large suit cases, this space having been purposely kept clear with large openings between the seat legs, as will be seen in Figs. 95 and 96. For smaller articles double parcel racks are fitted above the seats along the sides and on the end partitions of the interior.

The underframe is illustrated in Figs. 99 to 106. It is entirely of steel of British Engineering Standard sections, the solebars being 10 in. by 3½ in. by $\frac{3}{8}$ in. channels, and the centre longitudinals 9 in. by 3 in. by $\frac{3}{8}$ in. channels. The headstocks are of 12 in. by 3¾ in. by $\frac{3}{4}$ in. channels, and the main cross bearers of 10 in. by 3½ in. by $\frac{3}{8}$ in. channel section. Flat diagonal bracing, 4½ in. by $\frac{3}{8}$ in. is provided on the top of the frame. Gussets are $\frac{3}{8}$ in. thick. A feature of the underframe is the unusually deep trussing provided for the solebars, of 3½ in. by 3½ in. by ½ in. angles, as will be seen in Figs. 99 and 103. This not only gives great rigidity to the frame, but has the additional advantage of allowing the accumulator boxes to be brought well to the front, so that they are more easily accessible than is usually the case. From the main cross-bearers the 10 in. by 3½ in. by $\frac{3}{8}$ in. longitudinals are splayed towards the headstock, which is further stiffened by gussets. Cast steel side buffer brackets are provided and an angle stretcher carries a guide for the draw-bar. The draw-bar is fitted with 3 Hines indiarubber springs, while the side buffers have Spencer rubber springs with 1$\frac{7}{8}$ in. initial compression.

The bogies are illustrated in Figs. 107 to 112, page 161. They are also built up of British Standard sections, with solebars 10 in. by 3½ in. by 28·21 lb. The bogie headstocks are of pressed steel. The main cross bearers are pressed steel members of $\frac{3}{8}$ in. plate, 9 in. deep at the ends and 7$\frac{5}{8}$ in. deep at

the centre, with $5\frac{7}{8}$ in. and 3 in. flanges. The longitudinals are also of $\frac{3}{8}$ in. plate, $5\frac{1}{8}$ in. and $6\frac{7}{8}$ in. deep. The bolster is 1 ft. $1\frac{1}{4}$ in. wide, built up of two channels, 7 in. by 3 in. by 17·56 lb. section, with flanges facing inwards, and $\frac{1}{2}$ in. top and bottom plates. The spring plank is a $\frac{7}{16}$ in. plate pressing 1 ft. $\frac{5}{16}$ in. wide, slung from the transoms by inclined links. The bolster springs consist of double helical springs on each side. Laminated plate springs are fitted above the axle boxes, with rubber spring pads for the hangers. The centre is of cast steel cup. Side bearers are fitted at the bolster ends, with corresponding plates on the underframe cross-bearers. $1\frac{1}{4}$ in. side play is allowed either way to the bolster inside the bogie frame. The wheels are of the disc type with tyres held by retaining rings. The journals are 9 in. by $3\frac{3}{4}$ in.

The coach is fitted with the vacuum brake, one 18 in. cylinder attached to the main underframe being provided for each bogie, the estimated power at the blocks being calculated at 80 per cent. of the weight of the car, the latter being 27 tons. We are indebted to Mr. R. W. Reid, M.I.Mech.E., Carriage and Wagon Superintendent to the Company, for the facilities which have enabled us to illustrate this coach so fully.

Mechanical lubricators for axle boxes and the cylinders of locomotives of the type illustrated in Figs. 113 to 117 on page 162, have been introduced by, and are to be seen at the stand of, Messrs. Gresham and Craven, Limited, at the British Empire Exhibition. The pumps are arranged at each side of the oil chamber, from which the oil is drawn into them through the gauze at the foot. The cylinders are supported by a shank containing the oil passages and held in position by a nut. The rocking motion given to the driving frame is obtained from the valve gear in a way that is described below. This motion raises and lowers the plungers, which are made of two diameters, so that double-acting operation is obtained. Three-ball valves suffice for the operations of delivery and suction for the two ends. As the plunger rises, oil is drawn into the lower end of the cylinder, while delivery is effected from the other end over the top of the second valve, and through between the ball and seat of the third. On the down stroke the delivery partly goes to fill the top end of the cylinder and partly is delivered. The system of working is one that ensures continuity of supply and the actual design is such that the parts can be got at readily for inspection. The free wheel type of clutch illustrated in Figs. 115 and 116 is used to convert the rocking motion taken from the valve gear (see Fig. 117), into a rotating one, always in the same direction, for the shaft. Near the two ends there are wider parts of the shaft, which are circular but eccentric with the general shaft. These parts turn in suitable holes in the side arms of the driving frame, which is thus made to rise and fall carrying with it the plungers of the pumps. A warming pipe for use in cold weather is provided at the foot of the casing.

An exhibit of distinct novelty for this country is that of appliances for signalling on the double-wire system, to be seen at the stand of the Westinghouse Brake and Saxby Signal Company, Limited. The double-wire system is not in use on the railways of this country, though small tentative installations have been made in yards. It is, however, very extensively used on the Continent. The system devised by the Westinghouse Company is especially intended for British and Colonial lines. Although we cannot enter into a detailed discussion of the merits of the single and double-wire systems, it may be pointed out that the latter possesses many advantages. In the single-wire system a weight which are bars that, through levers, work in conjunction with the catch handle. The double-wire systems employ a drum at the lever frame, rotated by the lever in one direction or the other, and drawing in one wire while paying out the other. The drum in the Westinghouse frame gives a stroke of about 18 in. to the wire. The lever is short and at a convenient height. To operate, the catch is gripped in and the lever pulled right down to the inverted position, as shown in the centre of the frame in Fig. 118. Two badges are fixed to the lever so that whatever its position its function is apparent.

It is obvious that the double wire system might be crudely installed in such a way that the signalman would be unacquainted with the fact that a signal or point-wire had broken, and that these appliances had not responded to his lever movements. Wire failures are, we believe, very rare where the system is in extensive use, but even should such occur they are effectively provided for and perfect protection is assured. In the Westinghouse system the various parts are fitted with suitable checks to meet this contingency. As we shall explain later, these are fitted to both the point and signal gear, while a breaking wire detector is embodied in each lever at the frame. This consists of a bent metal piece in connection with the wire passing over the lever drum. If a wire should break and become slack on one side or the other, the detector tilts and comes in contact with notches on the frame casting, preventing further movement of the drum.

We propose first to deal with signal operation for

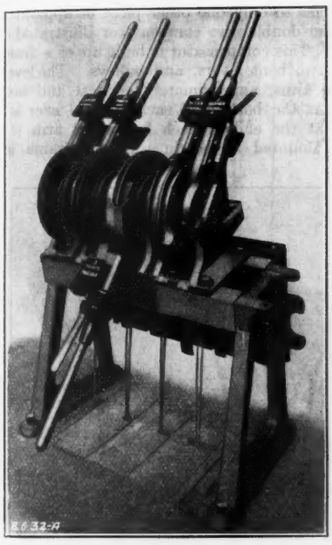


FIG. 118.

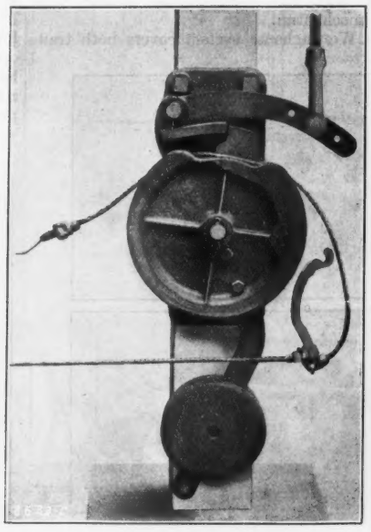


FIG. 119.

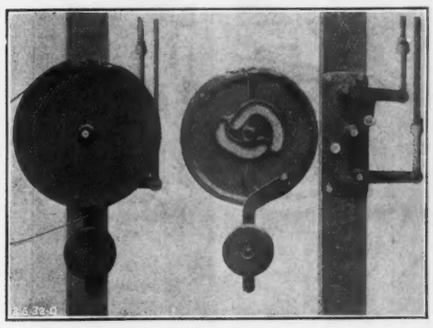


FIG. 120.

FIG. 118. DOUBLE-WIRE LEVER FRAME. FIG. 119. DOUBLE-WIRE SINGLE-ARM POST GEAR. FIG. 120. DOUBLE-WIRE DOUBLE-ARM POST GEAR; THE WESTINGHOUSE BRAKE AND SAXBY SIGNAL COMPANY, LIMITED.

which the double-wire system offers unique facilities. In addition to the simple movements of individual arms, the system can be readily applied to the operation of two signal arms for two positions each, or to three-position signalling. It is, in fact, extremely practical when applied to the latter, while in connection with the operation of two separate arms it can be usefully applied where outer and warner signals are on the same post, or for the operation of home and distant signals on separate posts. Taking the simplest case first of a single arm, the signal post gear employed in the Westinghouse Brake Company's system is illustrated in Fig. 119. The wire is wrapt round a drum pivoted on the post. On the inside of this drum is a cam slot in which works a pin projecting at right angles from an arm on the curved lever above, to which the signal down-rod is connected as shown. The cam slot is so designed that when the drum is in the position shown the rod is in its lowest position and the arm set at danger. When the drum is revolved in a clockwise direction the lever pin is moved by the cam further away from the centre and the down-rod is raised; consequently the arm is lowered to the "off" position. The drum will be seen to have fixed to it, by a bent lever, a heavy weight. When the arm is pulled "off" this weight is swung round into the upper left quadrant, in which position it remains so long as the signal is "off." Should the "danger retaining" wire (the upper one) break, as shown in Fig. 119, if the signal is "off," this weight will swing the

drum round and the signal arm will be at once returned to danger, the wire being disengaged from the drum in this movement. The freeing of the wire is automatically accomplished by means of the bent clip shown. This normally lies in the rim of the drum, the hooked end passing under a pin whose position in the rim may be seen in our illustration. So long as both wires remain taut this clip works as part of the drum. If the upper wire breaks disengagement follows. It is, of course, evident that if the lower "pull to clear" wire breaks no danger can arise from the arm showing the line to be clear. Although a weight will be seen to be fitted at the post, this is only of small size, being merely required to actuate the arm and down rod when unconnected from the ground gear. A stop is provided to prevent the weight swinging the disc too far and damaging the down rod lever, while the cam slot is over-run at both ends so that a definite movement is always given to the arm regardless of the actual stroke of the wire.

Although three-position signalling may be considered to be the next simplest arrangement as far as the post gear is concerned, we will defer reference to that for the moment and deal with double lever signal mechanisms. For double lever operation the special combined unit shown on the right of the frame in Fig. 118 is employed. The two levers there shown control a single drum, and after the normal stroke has been given to this by one lever, the second can be operated to give a further movement to the wire, thus giving a maximum movement of 3 ft. For double-arm operation, on a single post, the drum illustrated in Fig. 120 is employed. To the left of this figure is shown the drum as it appears on the post, while in the centre and right are shown the drum with its cam slots, and the two rod levers on the post. Part of each cam slot is circular and struck from the drum centre. For the remainder the radius is changing, so that for part of the movement each lever is displaced away from the centre, and for part, the movement is continued without effect on the levers. The combination will be clearly followed in Fig. 120. The upper slot controls the top arm, and the first "pull to clear" movement raises the lever for this arm, where it is held. During this movement the pin for the lower arm lies in a circular portion of the lower slot, and this arm is, therefore, not affected. For a further movement, effected by the second lever of the double unit in the frame, the pin for the top arm rests in a circular part of the slot, while the lower pin is displaced radially, the lower arm thus being actuated. The above application is for outer and warner signals for the same line, but the cam slots are easily arranged for directional indication, in which one signal is used for the main line and the other for a loop or branch. In this case it is a question of giving the drum a stroke in each direction, movement one way affecting one arm, while the pin for the other is stationary in a circular length of the cam slot, and movement the other way operating the second arm, the first remaining unaffected. The double lever unit may also clearly be applied to the operation of distant and home signals on separate posts, by the use of a suitable drum and cam on each post. Three-position signalling embraces the same fundamentals. The double lever unit is employed, and a single cam slot drum similar to, but larger than, that shown in Fig. 119. The slot is a compound curve which results on the first motion in the arm being raised to the 45 deg. position, and, on the further movement, to the vertical. We think this will be clear without further detail, and as this is hardly the place to enter upon the subject of three-position signalling as such, we now propose to deal briefly with the Westinghouse double wire point mechanism.

The Westinghouse system covers both trailable and non-trailable point lay-outs. The non-trailable arrangement, as being probably of the greatest interest in this country, is illustrated in Figs. 121 and 122. The lay-out in Fig. 121 shows an example fitted with locking bar and mechanical detection. The actual operating mechanism is shown in Fig. 122. The points are worked by an adjustable crank, the arm of which is seen projecting from the box, on the right. This crank is pivoted on the box. Inside the box it is given a shape somewhat resembling that of a racquet, the centre being cut out to a special profile to form a cam, which is worked by a pin attached to the wire drum or pulley. This pin is shown just below the block marked A in the upper view in Fig. 122. On the drum being revolved by a movement of the lever in the frame and the wires, this pin works the cam end of the crank and the points are operated. The cam profile arranges for escapement at either end of the movement. The locking-bar lever is worked by a pin on the wire pulley and rod, as can be clearly followed in Fig. 121, but the lay-out of this can be arranged to suit any particular practice. The plunger lock will be readily recognised, and this may be easily combined with mechanical detection in conjunction with the signal gear. Various other arrangements are possible, including, among the firm's standard designs, electrical detection.

A feature of the operating mechanism is the broken-wire detector, which is shown after a failure in the lower view of Fig. 122. The block A, held in the rim of the drum, is attached to the wire. So long as both wires are taut the block remains snug in its recess. If, however, the wire should break, the pull on the other wire cants the block so that it engages with a pawl B fixed in the box, preventing further movement. The boxes and drums are made to standards, so that one pattern can be applied in different ways.

In trailable lay-outs each tongue is worked by a separate rod connection. The rods are coupled direct with bars passing, by way of slots, through the box at right angles to the track. Each rod is worked independently by a crank pin on the drum, and each tongue can be locked against the stock rail. In this arrangement the locking bar stands normally above rail level, under which conditions the points can be operated. The depression of the locking bar compresses a spring and operates a lock which holds the drum fixed. The locking bar is not thrown over as in the ordinary system, but, whichever way the points are thrown, merely stands slightly above rail level when unloaded.

In concluding our notice of this exhibit of the Westinghouse Brake and Saxby Signal Company, we can refer to only one other piece of apparatus. This is the double-wire compensator illustrated in Fig. 123. This compensator is built up of a frame carrying two bent levers, and pulleys. The levers have two arms, approximately vertical and horizontal. At the bottom of each vertical arm is a pulley; at the end of each horizontal arm is a weight. Mounted in bearings in the frame are two other pulleys, and the wires are carried over these and over the corresponding lever pulley, in the run between the points or signal and the lever frame. Pivoted at its lower end to the frame is a rectangular bar extending upwards through the jaws of a fitting attached to both the horizontal lever arms. This bar is a loose fit in the jaws, and, in the event of any expansion or contraction of the wires, the change is taken care of by the equal falling or rising of the weighted arms, the jaws of the clip sliding over the bar freely. When, however, a pull is exerted on one wire or the other, the extra strain on the one side draws the two wheels for the wire pulled in towards each other, tending to raise one weighted arm slightly above the other. As soon as this movement occurs the jaws are closed, on account of the slant given to the link coupling them decreasing the horizontal distance between their centres. The jaws in closing in automatically grip the bar and prevent further movement of the levers. The gear is thus held immovable during lever operation, but is otherwise free to perform its function of compensating for any change of the wires.

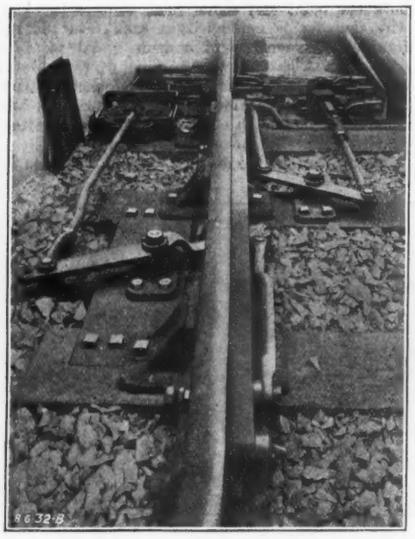


Fig. 121.

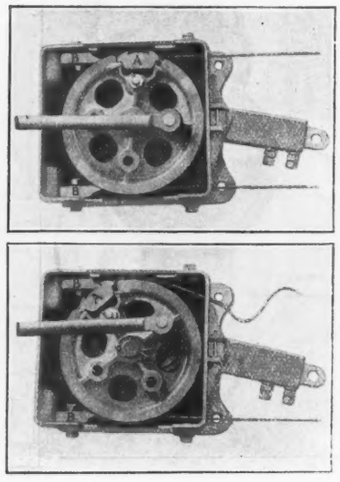


Fig. 122.

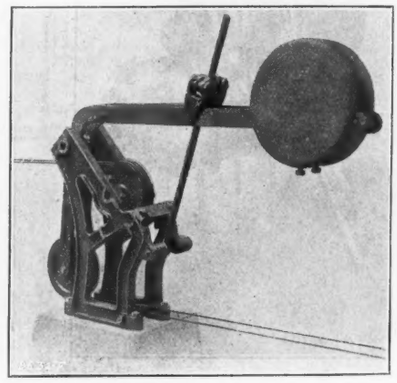


Fig. 123.

Fig. 121. Non-Trailable Point Lay-Out. Fig. 122. Non-Trailable Point Mechanism. Fig. 123. Double-Wire Compensator: The Westinghouse Brake and Saxby Signal Company, Limited.

1½-TON ELECTRIC OVERHEAD TRAVELLING CRANE WITH UNDERSLUNG BRIDGE.

A travelling crane for a workshop or store with the unusual feature of an underslung bridge, which can be moved along the length of the crane to reach loads and deliver them outside the main bay, was

1½-TON ELECTRIC OVERHEAD TRAVELLING CRANE WITH UNDERSLUNG BRIDGE.

CONSTRUCTED BY MESSRS. JOSEPH ADAMSON AND CO., ENGINEERS, HYDE, CHESHIRE.

Fig. 1.

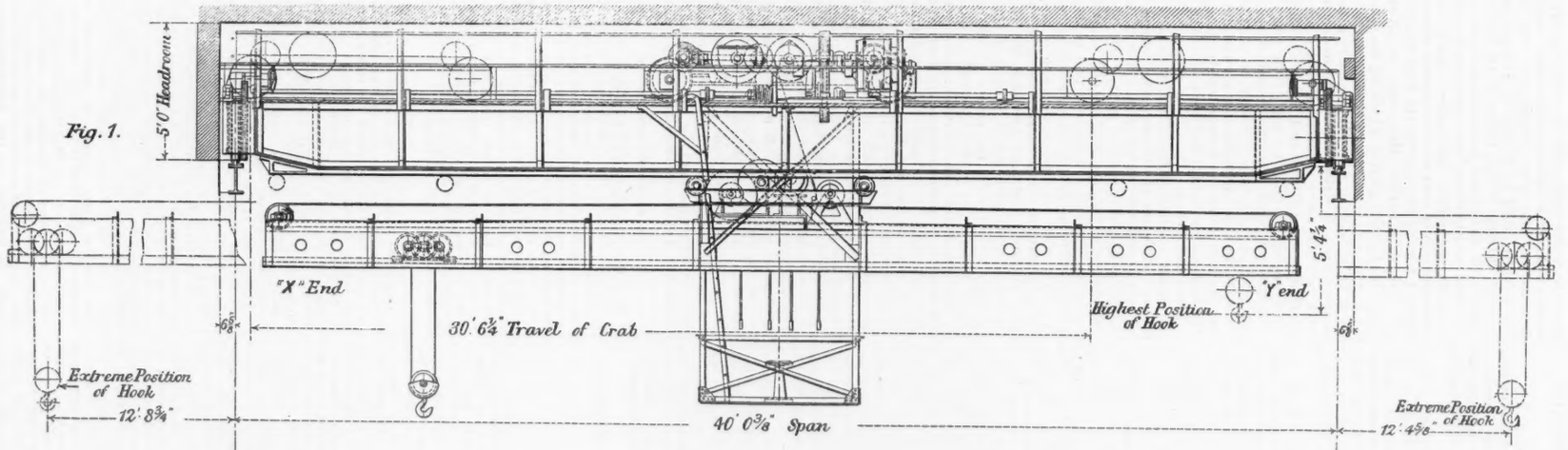
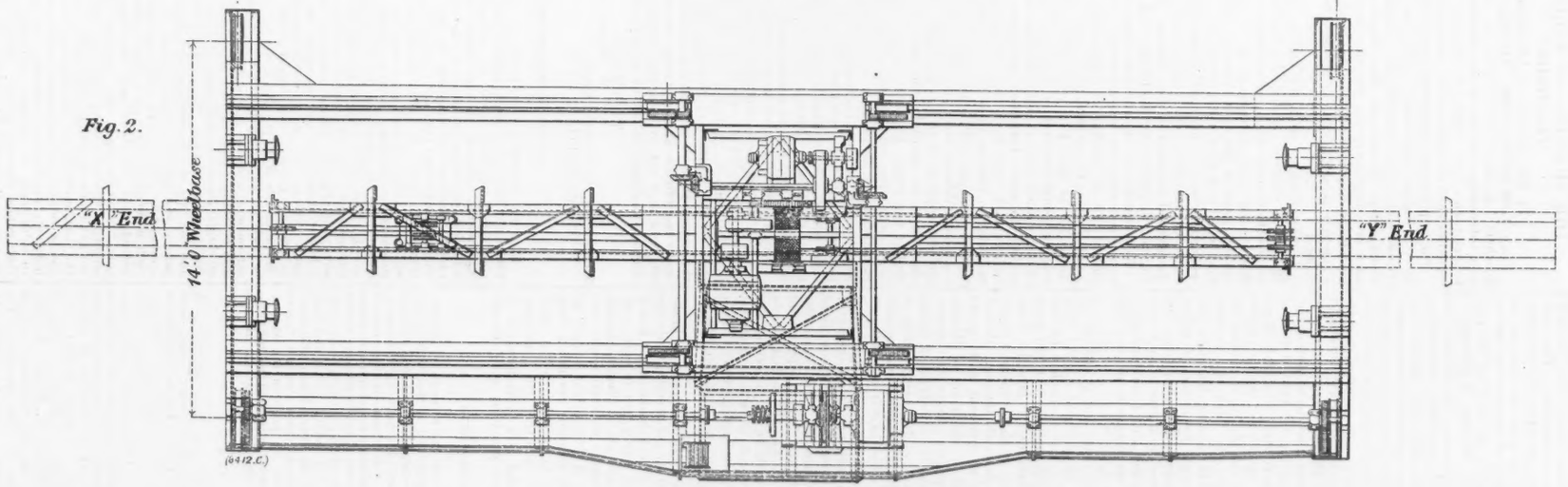


Fig. 2.



(6412.C.)

recently constructed by Messrs. Joseph Adamson and Company, of Hyde, Cheshire, for the Wolverhampton Corrugated Iron Company, Limited, of Ellesmere Port. The system of construction of this crane, which is of 1½ tons capacity, may be seen from the illustrations above and on page 168. The arrangement of underslung beam or bridge shows to best advantage when the crane is used to transfer goods from one side to the other of the workshop without travelling longitudinally, and this is the use to which it will be largely put, for in actual service it will be used to transfer goods from barges on one side of the workshop into store sheds on the other. The general lay-out of the crane and its equipment may be seen from the elevation and plan in Figs. 1 and 2, above. The crane, as assembled in the constructor's works, is shown in Fig. 3, and it will be noticed that the underslung bridge is shown extended to represent the handling of loads outside the bay of the workshop. The span of the crane is 40 ft. 0⅜ in. between the centres of the gantry girders, and the load is carried by a travelling jenny on the suspended bridge, which is 37 ft. long. When fully extended the load can be lifted at a distance of over 12 ft. from the centre line of the main gantries. The main girders of the crane are of box section and stiffened with internal plates. On the top flanges of these the rails are held in position by means of clamps set at 12 in. pitch (see Fig. 4). The clamps are shaped to fit the bottom flanges of the rails, and thus prevent any tendency to turning. Accurately fitted bolts, the heads of which are on the outside of the box girder, hold these clamps in place. This design will be appreciated as possessing many advantages when it becomes necessary to replace a worn rail.

Messrs. Joseph Adamson and Company have, since 1894, advocated the use of separate motors for each motion of a crane, and in the example under consideration this practice has been adopted. The motor for travel along the workshop and the brake for its control are attached to a common bed plate, situated in a central position on the side of one of the main girders at the platform level and with provisions for easy access for inspection and overhaul. This motor is of 10

brake horse-power and gives a longitudinal travel of 250 ft. per minute. A spring loaded slipping clutch is fitted to the longitudinal motion, and comes into operation if the suspended bridge should foul the shop stanchions when the crane is travelling. The crab is a rigidly braced structure mounted on four runners, all of which are connected by gears to a motor of 6 b.h.p., which gives a speed of traverse of 100 ft. per minute. Spring buffers are provided on the end frames of the crane to reduce the risk of damage to the structure by careless operation. To prevent the crab from tipping up, due to accidental overloading, the substructure is provided with four runners engaging with a track rail on the underside of each main cross girder. Cast steel wheels and forged steel pinions with machine-cut teeth are used throughout the crane, the first motion gears of which are enclosed in gear-cases which are flooded with oil to ensure durability and to eliminate noise. With the exception of the bevel pinions driving the cross traverse motion of the crab, there are no overhung gears. Like the main runners, those of the crab have steel tyres shrunk on the wheel centres, and the spur rings used to drive them are secured in position on the wheel centres by turned bolts. The axles revolve with the runners and are provided with self-lubricating bearings, the lubrication for which is effected by means of rollers floating in an oil bath below each bearing. The rotation of the axles is effected by means of an eccentric collar turned on the axle, and a corresponding recess bored in the boss of the runner in place of the usual system of key and keyway.

The cage is underneath the crab, and at one side of it. This ensures that the operator has a good view of the load. It contains the four controllers for the motors and self-contained resistances which are fixed overhead. The controller handles are brought down opposite the operator's seat so that control can be made with the minimum of physical exertion. Powerful magnetic blow-outs are an inherent part of the construction of the controllers, which are of Messrs. Joseph Adamson and Company's design and manufacture. The magnetic field is concentrated beside the contacts, and the efficacy of the arrangement is apparent from the fact that little deterioration has been observed at the contacts after 10,000 reversals on maximum load. As the resistances are contained within the substantial and well-ventilated casing of the controller, the risk of loose external connections causing short circuits is eliminated. The controller contacts and fingers are of drop forged copper, and so arranged that they can be quickly replaced from the front of the controller without disconnecting any joints or dismantling any part of the equipment. Before being sent out the controllers are tested under load and are also subjected to an insulation test at 2,000 volts pressure.

Hoisting is effected by an electric motor of 10 brake horse-power at a speed of 63 ft. per minute, while the jenny travel is operated by a 3 brake horse-power motor giving a movement of 100 ft. per minute. All the motors fitted to the crane are of Messrs. Joseph Adamson and Company's totally enclosed heavy service type, working from a direct-current supply at 220 volts pressure. All the motions are fitted with automatic electric brakes to bring them to rest when the controller is thrown over into the "off" position. These brakes are of the rigid arm type arranged to be easy of adjustment and provided with Ferodo brake linings.

Open Hearth Siemens Steel Furnace.—Messrs. Vickers' Limited have just installed at their Barrow-in-Furness works a new open-hearth Siemens steel furnace of the latest type, built and designed by Wincott's, of Sheffield. The capacity is between 10 tons and 20 tons per heat, and it is now possible to get a total output from the steel foundries at the Vickers Barrow works up to 300 tons of castings per week, ranging from a few pounds weight each to a 20 ton casting. The first heat was tapped from this furnace on July 18 last, with very successful results, as determined from the test figures and analysis, and it will now be possible for Messrs. Vickers Limited to give special attention to inquiries for steel castings of every description up to 20 tons weight.

Forthcoming Conference on Illumination.—A Conference of "Illuminating Engineering" has been arranged to take place at the British Empire Exhibition on the afternoon of August 12, commencing at 2.30 p.m. Among other items a Report of the Proceedings at the Meeting of the International Illumination Commission held at the First International Conference on Industrial Hygiene, recently held in Geneva, will be presented and development in connection with the lighting of schools and factories will be discussed. A paper entitled "The Illumination of Highways from the Motorists Point of View" will be read by Edward H. Fryer. Further particulars and free tickets for the conference will be obtainable in due course from the Hon. Secretary, The Illuminating Engineering Society, Mr. L. Gaster, 32, Victoria Street, S.W. 1.

LETTERS TO THE EDITOR.

"THE TRAINING OF ENGINEERING TEACHERS."

To the Editor of Engineering.

Sir,—Your article on the "Training of Engineering Teachers" in the current issue of your journal is very interesting, but the writer has not distinguished between the two types of teaching, and suggests remedies that will not be very effective.

The pupils in an elementary school are very young, have a limited experience of life, are therefore uncritical and easily impressed by a teacher with an air of authority. To instruct these pupils, whose attendance is compulsory, the teachers have a superficial knowledge of a large number of subjects and the air of a superior person, acquired, presumably, at a training college.

Technical school students, on the other hand, are at least 16 years of age and of a critical turn of mind, due to their works or secondary school experience. In most cases their attendance at evening classes is optional, and is due to a desire to obtain knowledge that will be of use to them in their daily work. The technical school teacher has the same general knowledge as the elementary school teacher, but if he cannot give the desired information the interest of his class will flag and discipline and attendance will suffer.

As a remedy for this state of affairs it seems obvious to suggest that the teacher shall know his job. To ensure this no teacher of engineering should be appointed unless he has earned his living in an engineering works for at least two years after graduating. The teacher would then come to his work with a knowledge that he must have something more than merely the ability to solve text-book problems. During these two years he will have time to arrange his teaching material on lines to show the relation between fundamental principles and the cases arising in practice. By constantly thinking over his college-acquired knowledge and its application to the problems he meets during the two years interlude, the prospective teacher will find he can impart his technical information to a class in an interesting and methodical way, with no difficulty in maintaining discipline or attendance. He will also gain the confidence of his pupils in the same way as a properly qualified part-time teacher, and for the same reason, viz., because the pupils realise the teacher knows what he is talking about, and is not reciting information acquired as a bookworm.

This suggested remedy would eliminate the stop-gap teacher, as you wish, and also the elementary school teacher who leaves his own work for the higher pay of technical schools. When a man trained in this way rises to the position of Principal, his knowledge of the organisation of engineering works will enable him so to co-ordinate and supervise his classes that the students will obtain a sound engineering education without wasting time on the hobbies of his teachers.

Yours faithfully,

W. Booth, A.M.Inst.C.E.

Holmeleigh, St. Georges, Salop,
July 28, 1924.

Lloyd's Register of Shipping.—So much of the business of underwriters, shipowners, merchants, shippers, and others depends upon the possession of reliable information relating to individual vessels that considerable importance attaches to the issue each year by Lloyd's Register of Shipping of the Register Book, which forms by far the most complete source of information of this kind. The 1924–25 edition, a copy of which we have just received, contains the usual data on steamers, motorships, sailing vessels, trawlers, &c., constituting the merchant fleets of all countries of the world. This alone would naturally go to form a bulky volume, but, in addition, numerous supplementary sections containing lists of vessels of special types and a list of shipowners and managers, are included in the main volume. In an appendix, issued as a separate volume, are given a list of signal letters, a list of changes in the names of ships, and a list of compound names, as well as lists of shipbuilders, insurance companies shipowners' societies, docks, &c. The appendix volume also contains a vast amount of valuable statistical data on shipping matters, with some of which we have already dealt on page 98 *ante*. The book is issued to subscribers, and the rate of subscription for marine insurance companies and public establishments is 12 guineas per annum for a single copy and 6 guineas per annum for each additional copy; or if the copies are periodically posted with additions and corrections in type, the subscription for each copy supplied is 20 guineas per annum. For other subscribers the charge is 10 guineas per annum for each copy which is kept posted throughout the year, and 6 guineas for copies not so posted. Supplements containing the necessary additions and corrections, however, are issued at intervals, and are supplied gratis to subscribers not resident in London and not having their copies regularly posted. In this way, the information in the Register Book is kept up to date at all times—a feature which materially augments its utility.

FIRE-RESISTING BITUMEN.

For many industrial purposes bitumen has only found restricted application because it is very inflammable, and also is liable to soften under certain temperature and atmospheric conditions. Our attention was recently called by Messrs. D. Anderson and Son, Limited, of Lagan Works, Belfast, to the fact that their chemist, Mr. R. O. Child, had succeeded in the discovery of a treatment to change the characteristics of bitumen to render it fireproof and make it more stable. A demonstration of what the new material will withstand without burning was made at the Park Road Works of the firm at Stretford, Manchester, on Wednesday, July 23. For this purpose a building was constructed, 21 ft. long, 7 ft. 7 in. wide, and with a height varying from 10 ft. 6 in. to 8 ft. It was divided into three compartments by brick walls. The roofs were made with tiles and slates on fireproof rafters for the two outer sections, and of treated bitumen roofing felt on plain wooden boarding for the middle one. In each compartment wood and other combustible material was piled up to the extent of one-third of its volume.

In the first test the material in the two end sections was ignited. Soon the temperature in these parts of the building was so high that the glass of the windows cracked and melted. The tiles of the roof broke into fragments and the slates of the other part suffered injury. Although the flames came through the roof in both sections the treated bitumen roof of the middle section remained completely intact. The application of water to the tiled and slate roofs led to cracking and extensive breakage. In the next part of the test the treated bitumen felt roof was subjected to direct heating by starting a fire in the section it covered. Although subjected to a temperature sufficient to melt glass (between 3,000 and 4,000 deg. F.), the roofing remained intact, and, indeed, showed no effect of the heating. When water was poured on the roof afterwards it showed no tendency to melt, break or crack.

This remarkable demonstration, showing the good fire-resisting properties obtained by the treatment of a material which is normally highly inflammable and which melts at 250 deg. F., gives some indication of increased scope for use of a material with many valuable properties. It is not only in its use for roofing purposes, however valuable that may be, that the test showed the value of the Anderson treatment. There are many other purposes, such as electrical insulation work of various types and the treatment of road surfaces, in which the properties of this treated bitumen may prove serviceable. It may be noted that some 18,000 sq. yards of roofing material treated by the Anderson process are already in use at Wembley. Endeavours are being made to obtain the revision of old local bye-laws to permit the use of treated bitumen roofs for dwelling houses, for which purpose it has the advantage of cheapness as well as that of fire resistance.

The British Cast-Iron Research Association.—A further stage in the development of the Cast-Iron Research Association was reached a few days ago, when the new laboratories at Guildford-street, Birmingham, were taken over from the contractors. These laboratories are well equipped for the research work of the Association, which will, however, continue its policy of having investigations conducted by prominent workers in some of the university laboratories and in the works of members. Between 6,000*l.* and 7,000*l.* is to be spent during the financial year, which started on July 1, on research work on the corrosion resistance of cast iron, heat-resisting cast iron, iron for electrical and magnetic purposes, and other problems.

Merchant Shipping Losses.—Returns just issued by Lloyd's Register of Shipping indicate that, during the last quarter of 1923, a total of 139 steamers, motorships and sailing vessels, having an aggregate gross tonnage of 147,255, were lost, condemned or otherwise removed from the register. The losses of Great Britain and Ireland amounted to 56,626 tons (29 ships), the tonnage representing 0·29 per cent. of the total owned in this country. In the case of Japan, 9 vessels were lost, having an aggregate tonnage of 19,243, which constitutes 0·53 per cent. of the total Japanese merchant tonnage The United States shipping losses (19,238 tons) were practically the same as those of Japan, although relatively lower, owing to the larger total tonnage owned in the former country; the proportion lost by the United States amounts to 0·13 per cent. of the total tonnage owned. The losses of other countries in order of magnitude were as follow:—Germany, 11,227 tons (0·43 per cent.); Italy, 8,148 tons (0·27 per cent.); British Dominions, 7,096 tons (0·26 per cent.); Norway, 6,940 tons (0·27 per cent.); and Sweden, 6,671 tons (0·55 per cent.). The Swedish losses, it may be mentioned, were proportionally higher than those of any other country. We should perhaps explain that the figures quoted above do not include cases of breaking up, condemnation, &c., which are not known to be due to stress of weather, &c. A total of 168 vessels, making 389,993 tons together would be included in the last-mentioned category, and of these ships, 20, amounting to 54,315 tons, were owned in Great Britain and Ireland.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—While the local iron and steel industry shows slight signs of revival, the situation on the whole remains practically the same as a month ago. Though competition from Germany and other Continental countries has tapered off, trade organisers in an effort to stimulate buying have taken contracts that have yielded little, if any, profit, but have merely kept staffs employed and machinery running. Inquiries during the past week have been more numerous, especially from the Colonies in respect of railway steel, tramway trackwork of manganese steel, and agricultural machinery and electrical plant in connection with development schemes which, it is expected, will be entered upon shortly. The shipbuilding industry, which of late has been somewhat depressed, is showing welcome signs of revival, as seen in the increased demand for shipbuilding steel and marine castings and forgings. One of the busiest sections of the heavy trade is the railway department, where makers of axles, tyres and wheels are engaged on recently placed contracts and also colliery requirements. The call for automobile steel is fairly strong in spite of the dropping of the McKenna Duties, but it is believed that an adverse effect will be felt in the near future. In the lighter trades, manufacturers report improved business for saws, tools, files, picks and shovels, in which the Colonies are big purchasers, while Russia is taking a small quantity of saws on a strictly cash basis.

South Yorkshire Coal Trade.—Business during the past week has been of a very restricted character in spite of the recent reductions made in prices. The output at pits continues to be in excess of the demand, and in consequence big stocks are accumulating at colliery sidings. The call for best steam hards is fairly strong for home consumption, though the amount going away for shipment is far below the average. Cobbles and nuts show weakness, and merchants experience difficulty in disposing of them at reduced rates. Slacks have improved their position, especially in the better grades. Business in house coal is generally flat. Foundry and furnace coke are unchanged, but an improvement is reported in gas coke. Quotations:—Best branch handpicked, 32*s.* to 33*s.*; Barnsley best silkstone, 26*s.* to 28*s.*; Derbyshire best brights, 25*s.* to 27*s.*; Derbyshire best house, 23*s.* to 25*s.*; Derbyshire best large nuts, 21*s.* to 25*s.*; Derbyshire best small nuts, 15*s.* to 17*s.* 6*d.*; Yorkshire hards, 21*s.* 6*d.* to 22*s.* 6*d.*; Derbyshire hards, 21*s.* to 23*s.*; rough slacks, 12*s.* 6*d.* to 15*s.* 6*d.*; nutty slacks, 12*s.* to 14*s.*; smalls, 8*s.* to 10*s.*

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

Cleveland Iron Trade.—Business in Cleveland pig iron is on a very limited scale, and at the moment the outlook is very discouraging. Though much complaint is heard that quotations do not cover cost of production, a marked downward tendency continues. Reductions in prices fail to bring in buyers. What trade there is passing is almost entirely on home account, Continental iron continuing to undersell the products of this district in markets abroad. No. 1 Cleveland pig-iron, though still rather scarce, has fallen to 91*s.*, and other qualities are plentiful and weak in price. No. 3 g.m.b. is offered freely at 86*s.*; No. 4 foundry is put at 85*s.*; and 84*s.* is asked for No. 4 forge.

Hematite.—Unsatisfactory accounts are given of the East Coast hematite branch. Sales are difficult to arrange, and makers are now handicapped by quite heavy stocks. For Nos. 1, 2 and 3 up to 94*s.* 6*d.* is asked, but 94*s.* has been accepted. No. 1 is quoted 6*d.* above mixed numbers. Early curtailment of output is expected.

Foreign Ore.—There is next to nothing doing in foreign ore, but imports against contracts are heavy. Nominally, market rates continue to be based on best rubio at 23*s.* c.i.f. Tees.

Coke.—Durham blast-furnace coke is in very ample supply, and demand is only moderate. Good average qualities are on sale at 26*s.* 6*d.* to 27*s.* delivered to users in this district.

Manufactured Iron and Steel.—The galvanised corrugated sheet department continues to be the only really busy branch in manufactured iron and steel. Producers of sheets have about as much work on hand as they can deal with this year, and they report heavy inquiries still circulating. The export quotation for 24-in. gauge galvanised sheets is fully 18*l.* 5*s.* There is slightly more doing in shipbuilding material, and one or two orders for steel rails have been secured. Quotations generally are easy. The following are the recognised market figures for home business: Common iron bars, 12*l.* 10*s.*; iron rivets, 14*l.* 5*s.*; packing (parallel), 9*l.*; packing (tapered), 12*l.*; steel billets (soft), 8*l.* 10*s.*; steel billets (medium), 9*l.*; steel billets (hard), 9*l.* 10*s.*; steel boiler plates, 13*l.* 10*s.*; steel ship, bridge and tank plates, 10*l.* 5*s.*; steel angles, 10*l.*; steel joists, 10*l.*; heavy sections of steel rails, 9*l.*; and fish plates, 13*l.*

CITY OF LONDON COLLEGE IRON AND STEEL LECTURES.—It is announced that Mr. B. Kelly, M.I. and S.Inst., will conduct a course of lectures, commencing on Tuesday, September 30, at the City of London College, Whitestreet, Moorfields, E.C. 2, on iron and steel. The lectures will be specially adapted to suit the requirements of those engaged in export houses.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Trade.—Work in the South Wales coalfield and at the docks will be suspended for half the week next week. The miners are to have Monday, Tuesday and Wednesday off for the bank holiday and the coal trimmers and tippers will be idle on Monday and Tuesday and work two short shifts (from 8 a.m. to 12 noon, and from 12 noon to 4 p.m.) on Wednesday. In the meantime, though available supplies of coal are more than sufficient to meet the demand, the undertone of the market generally is rather steadier and in isolated cases buyers have been compelled to pay an extra 3*d.* per ton. Tonnage has reached port more freely, and chartering, too, has been rather more active, with the result that colliery positions have been improved. Much more new business is, however, needed to stabilise values, but the reduction in output which will be effected over the holidays is bound to lessen the quantity of coal available for disposal. At present best Admiralty large rules from 28*s.* to 28*s.* 6*d.*, with Monmouthshire's from 23*s.* 6*d.* to 27*s.* Smalls are from 12*s.* to 17*s.* 6*d.*, according to quality. Up to the present a new wage agreement embodying the terms of the national settlement, has not been signed for this district. Efforts to draft an agreement have so far proved abortive, the difficulty being to get the men's representatives to agree to conditions of working which it is calculated would reduce the costs of working. This is considered an absolute necessity. It is proposed that double shifts should be introduced, but the men seem to have a deep-rooted objection to this system, and already there have been strikes and stoppages at many collieries where the men have had the slightest suspicion of such a method of working being adopted, though the double shift is generally in vogue in other coalfields. Exports of coal as cargo last week amounted to 487,295 tons compared with 471,647 tons in the previous week. Shipments from Cardiff were increased from 271,300 tons to 314,230 tons; at Port Talbot from 42,950 tons to 54,570 tons, and at Llanelly from 3,330 tons to 4,710 tons. At Newport, however, they were reduced from 99,420 tons to 66,660 tons; at Swansea from 54,640 tons to 46,130 tons. Shipments to France were lowered from 180,920 tons to 162,460 tons, and to South America from 74,840 tons to 70,530 tons, but to Italy were increased from 76,810 tons to 100,330 tons, to Spain from 31,100 tons to 36,020 tons, and to British coaling depots from 32,900 tons to 36,170 tons.

Iron and Steel.—Exports of iron and steel goods from South Wales last week amounted to only 9,122 tons, those of tinplates and terneplates totalling 6,885 tons against 12,992 tons in the preceding week, blackplates and sheets, 1,515 tons against 3,561 tons, galvanised sheets, 394 tons against 1,980 tons, and other iron and steel goods, 329 tons against 773 tons.

THE CRYSTAL PALACE SCHOOL OF ENGINEERING.—The retirement of Mr. J. W. Wilson from the Principalship of the Crystal Palace School of Engineering was recently announced, when it was also intimated that he would be succeeded by his brother, Mr. Maurice Wilson. Sir Charles L. Morgan, President of the Institution of Civil Engineers presented the certificates to the successful students of the School on Tuesday last, and in his address emphasised the important work done by old students associations.

KAYE'S PATENT RAILWAY CARRIAGE DOOR LOCKS.—We are informed that the Great Northern Section of the London and North Eastern Railway have recently accepted the tender of Messrs. Joseph Kaye and Sons, Limited, of Leeds, for the supply of their patent locks for the next year. To the 29 trains, consisting of 290 carriages now being built for service on the Great Eastern Section of the Company's lines, it is also intended to fit these locks, orders having been received for the supply of 4,292 of them. The London Midland and Scottish Railway Company are also fitting these locks to their stock.

PERSONAL.—Messrs. W. H. Allen and Co., Limited, of Bedford, have appointed Messrs. R. Norman, Button and Co., of Central Chambers, High-Street, Sheffield, to represent them in that district for the sale of heavy fuel-oil engines. The firm will be associated with Messrs. Allen's Manchester office in this connection.—Mr. A. Fleming Browne, M.I.Mech.E., M.I.H.V.E., late of 33, King-street, Covent Garden, W.C. 2, has removed to 11, Carteret-street, Queen Anne's-gate, London, S.W. 1.—Dr. Leslie Aitchison, D.Met.B.Sc., F.I.C., of Birmingham, has given up his practice to take up a position as assistant to Mr. Horace W. Clarke, the managing director of James Booth and Co. (1915) Limited, of Argyle-street, Birmingham.—Messrs. Holden and Brooke, Limited, Sirius Works, West Gorton, Manchester, intimate that from August 1, 1924, existing agency arrangements in London terminate, and request that business be transacted through their own office, 315, Abbey-house, Westminster, S.W. 1, under the management of Mr. W. Richard.—Mr. F. S. Spiers, Secretary and Editor to the Faraday Society and Secretary to the Institute of Physics, has moved his office to 90, Great Russell-street, W.C. 1. (Telephone, Museum 5718.) The publishing office of the Journal of Scientific Instruments is now also at this address.—Messrs. W. Sisson and Co., Limited, Elmbridge-road, Gloucester, inform us that they have appointed Mr. A. Fleming Browne, M.I.Mech.E., M.I.H.V.E., of 11, Carteret-street, Queen Anne's Gate, S.W.1, as their London representative.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—Some of the Scottish steel works have made a partial start this week, but the majority of the works will not resume operations before next week. Old orders on hand are none too numerous, and bookings during the holiday period are not reported as anything like approaching heavy tonnage, so that there is little improvement in the trade yet. The usual number of inquiries have been going round the market, but the local makers are still faced with a certain amount of competition from the agents with Continental stuff to offer. Nevertheless, the outlook for the home producer is considered to be a bit better, largely because of the steady improvement which has taken place in the shipbuilding industry during recent months. The black sheet trade, which has been actively engaged for some time back, has again restarted, and as order books are extremely well filled the outlook for the remainder of this year causes no trouble. Buyers have been placing business very freely for light and galvanised sheets, but there is little sign this week of any improvement in the demand for the heavier gauges. Australia, India, South Africa and South America have each large consignments on order, and further repeats are expected. Prices are keeping steady and show no changes as under:—Boiler plates, 13*l.* 10*s.* per ton; ship plates, 10*l.* 5*s.* per ton; sections, 10*l.* per ton; and sheets, $\frac{1}{16}$ in. to $\frac{1}{4}$ in., 12*l.* 10*s.* per ton, all delivered Glasgow stations.

Malleable Iron Trade.—Repairs and overhauling of plant have been general in the malleable-iron works of the West of Scotland during the holiday period, and now that the latter is over there is not a great amount of work to start on. Bookings have been few, and even inquiries are of a very limited nature. On the whole, the prospects are not very bright for the immediate future. Prices are unchanged, with "Crown" bars still called 12*l.* 10*s.* per ton delivered Glasgow stations.

Scottish Pig-Iron Trade.—There has been no development in the Scottish pig-iron trade over the week, and the demand for hematite and foundry iron has not been heavy. Buyers have not much outlet at present, and few are willing to commit themselves until the general prospects get a bit brighter. Furnaces are still idle this week, and supplies are being drawn from stocks which are quite ample for all requirements. Prices are sagging, and to-day's quotations are given as follow: Hematite, 4*l.* 16*s.* 3*d.* per ton, delivered at the steel works; foundry iron, No. 1, 4*l.* 18*s.* 9*d.* per ton, and No. 3, 4*l.* 13*s.* 9*d.* per ton, both on trucks at maker's yards.

Shipments of Scottish Pig-Iron.—The shipments of Scottish pig-iron from Glasgow Harbour for the week ending last Saturday, July 26, amounted to 187 tons. Of the total, 90 tons went overseas and 97 tons coastwise. For the corresponding week of last year the figures were 2,742 tons overseas and 181 tons coastwise, making a total shipment of 2,923 tons.

Wages in the Iron Trade.—The examination of the books in the pig-iron trade for the months of April, May and June, shows that the average net selling price works out at 4*l.* 19*s.* 11*d.* per ton. The Board of Conciliation for the regulation of wages has therefore intimated that the wages of the workmen will be reduced by 1 per cent. on basis rates.

Shipbuilding Contract.—A contract has just been secured by Messrs. Fleming and Ferguson, Shipbuilders, Paisley, from the Crown Agents for the Colonies for a steamer of 750 tons gross and 950 i.h.p. This vessel, which will be supplied with engines by the builders, will be put into service on the West African coast.

THE GLASGOW CORPORATION TRAMWAYS.—In the thirtieth annual report of the Glasgow Tramway, which covers the year ending May 31, 1924, it is stated that the traffic receipts amounted to 2,318,699*l.* After allowing 260,168*l.* for depreciation, 203,319*l.* for permanent-way renewals, and other sums for sinking funds income tax, legal expenses, &c., the result of the year's working is a net balance of 49,199*l.* The Corporation own and operate a length of nearly 253 miles of tramway, measured as single track. Power for the tramways is mostly generated at the Pinkston Station, the generating cost being 0·576*d.* per unit, of which 0·282*d.* is accounted for by fuel. The average traffic revenue per car-mile decreased from 20·051*d.* to 18·772*d.* during the year, and the working expenses increased by 98,485*l.*

INTERNATIONAL CONGRESS ON ARCHITECTURAL EDUCATION.—An interesting programme has been outlined in connection with this meeting, which is taking place from July 28 to August 2. The President, Mr. J. Alfred Gotch, and Council of the Royal Institute of British Architects, held a reception at their headquarters, 9, Conduit-street, Regent-street, W.1, to welcome members of the Congress. A series of papers has been read by English, French, Italian and American authorities on the past, present and future of Architectural Education. Members of the Congress have visited interesting architectural features of the district, including the British Empire Exhibition, where they were conducted round by Sir John Simpson and Mr. Maxwell Ayrton, the architects to the Exhibition. Yesterday an informal meeting of teachers for the discussion of matters affecting the schools of architecture was held. To-day an all-day visit to Cambridge has been arranged, while to-morrow St. Paul's Cathedral, the City churches, the British Museum and Westminster Abbey will be visited, these visits concluding the proceedings.

1½-TON ELECTRIC OVERHEAD TRAVELLING CRANE WITH UNDERSLUNG BRIDGE.

CONSTRUCTED BY MESSRS. JOSEPH ADAMSON AND CO., ENGINEERS, HYDE, CHESHIRE.

(*For Description, see Page* 164.)

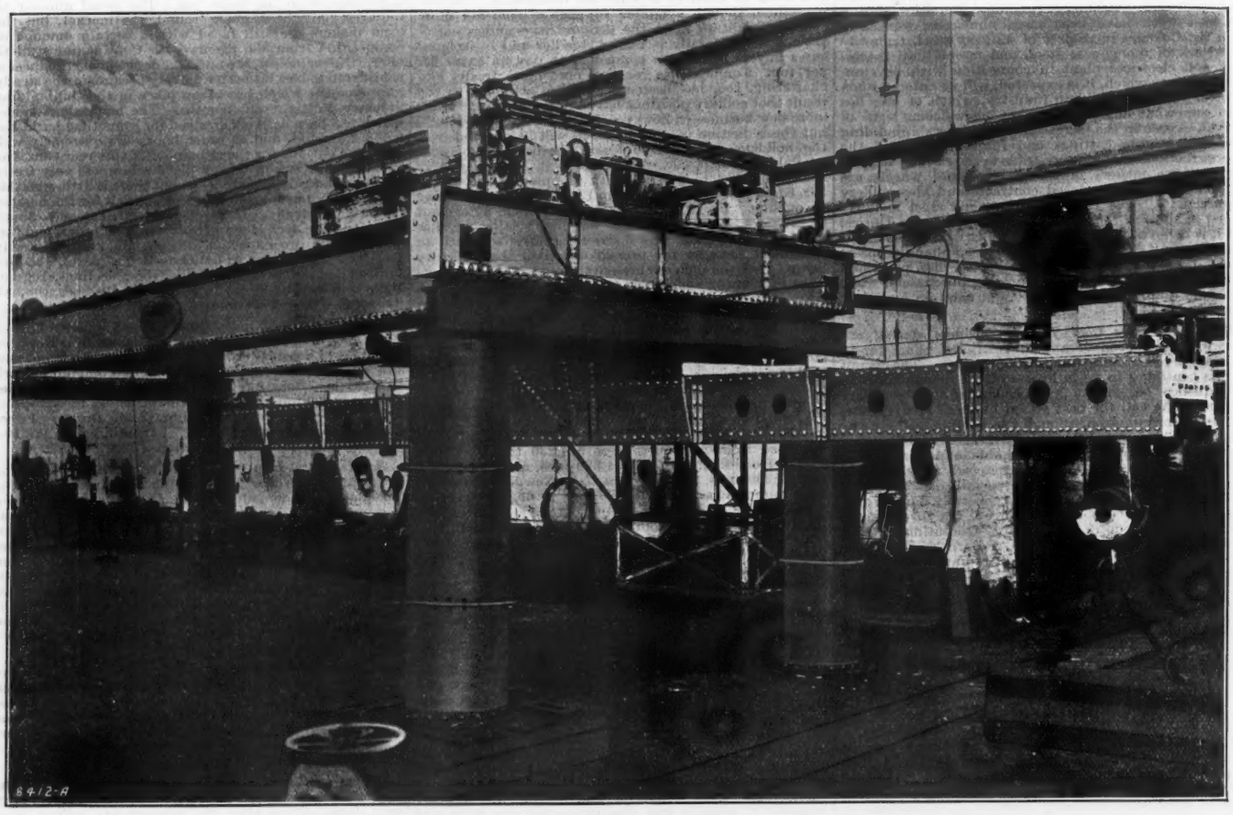


FIG. 3. CRANE ASSEMBLED IN THE WORKSHOP SHOWING THE BRIDGE FULLY EXTENDED.

CENTRIFUGAL PUMPS AND INTERNAL COMBUSTION ENGINES FOR ARGENTINA.—The Commercial Secretary at Buenos Aires reports that the Argentine National Sanitation Works are calling for tenders for the supply and delivery of pumping machinery and internal-combustion engines for the pumping stations of the water-supply systems of the towns of Junin, Rivadavia and San Martin (province of Mendoza). Tenders must be delivered by September 11. United Kingdom firms wishing to obtain further particulars, should apply to the Department of Overseas Trade, 35, Old Queen-street, London, S.W.1, quoting reference A.X. 1,129.

ALUMINIUM WHEELS FOR OMNIBUSES.—The London General Omnibus Company Research Department has been experimenting with an aluminium alloy road wheel, which, although only half the weight of the standard steel wheel, has given satisfactory results. A number of these wheels have now performed over 30,000 miles in service, and tests are being continued on upwards of 20 routes. The scrap value of the wheel is about two-thirds of its original value. The wheels make a large reduction in the unsprung weight and minimize road destruction.

GEOGRAPHICAL NAMES.—The endeavours to standardise the English spelling of geographical names, which have been undertaken by the Permanent Committee set up by the Royal Geographical Society and various Government Departments, are still proceeding. We have now received the "First General List of Names in the Empire of India," "First List of Names in Czecho Slovakia" and the "Second and Third General Lists of Oceanic Names." These are obtainable from the Royal Geographical Society, Kensington Gate, London, S.W. 7, at a price of 6*d.* each.

THE INSTITUTE OF COST AND WORKS ACCOUNTANTS.—A Conference of the Institute of Costs and Works Accountants was held at the Connaught Rooms, Great Queen-street, London, on Thursday and Friday, July 24 and 25. Lord Leverhulme presided over the meetings, and the subjects dealt with were "Administrative and Selling Costs, their Nature and Distribution," and "The Function of Costing in Industrial Relations." The Fifth Annual Dinner was held on Thursday, the 24th ult., when Sir George Paish, in proposing the toast of the Institute referred to the present trade depression in Europe as not being due to economic reasons, but to the state of international politics. In his reply, Lord Leverhulme contended that there could be no great progress if legislative actions in the early days of an industry imposed restrictions. The America position in the motor trade was due to the freedom that country enjoyed in early days from such enactments as that in Britain, which prescribed that a motor vehicle must be preceded by a man carrying a red flag. Other speakers were Mr. W. Howard Hazell, Sir Ernest Benn, Mr. A. Williamson, Sir John Keane and Sir William Berry.

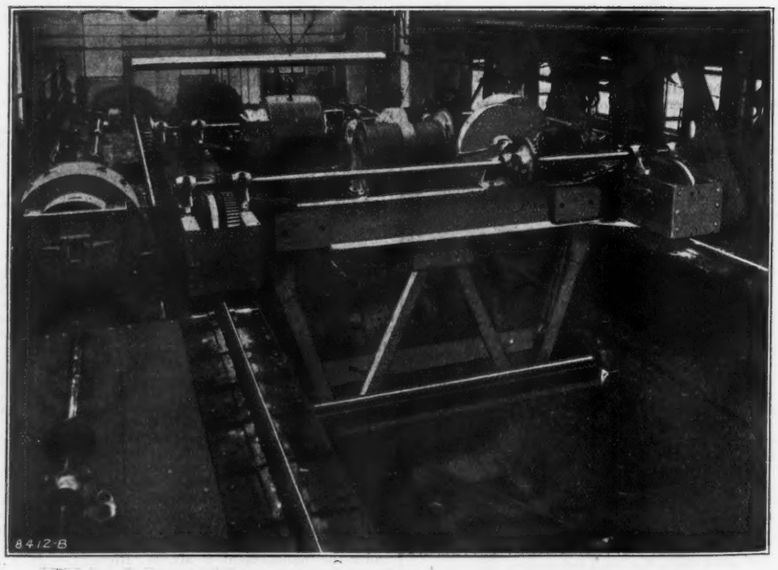


FIG. 4. VIEW SHOWING ARRANGEMENT OF THE CRAB AND METHOD OF SECURING THE RAILS.

L.M.S. RAILWAY THIRD-CLASS VESTIBULE CAR AT THE BRITISH EMPIRE EXHIBITION.

CONSTRUCTED AT THE COMPANY'S DERBY WORKS; MR. R. W. REID, M.I.MECH.E., CARRIAGE AND WAGON SUPERINTENDENT.

(*For Description, see Page* 160.)

Fig. 89.

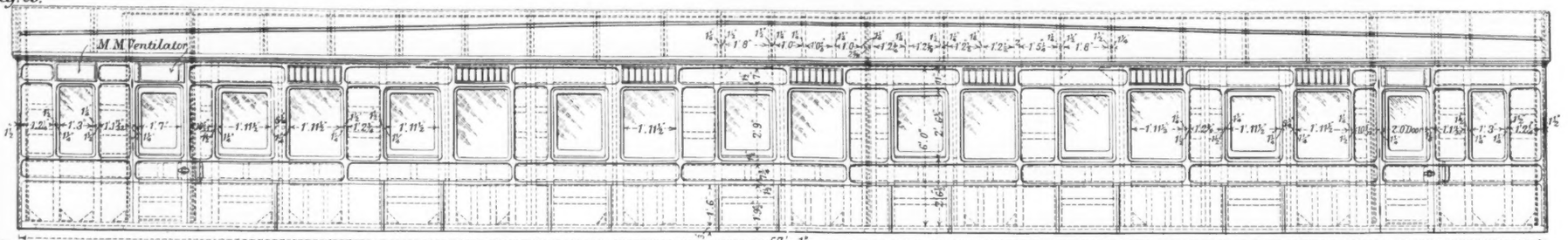


Fig. 90.

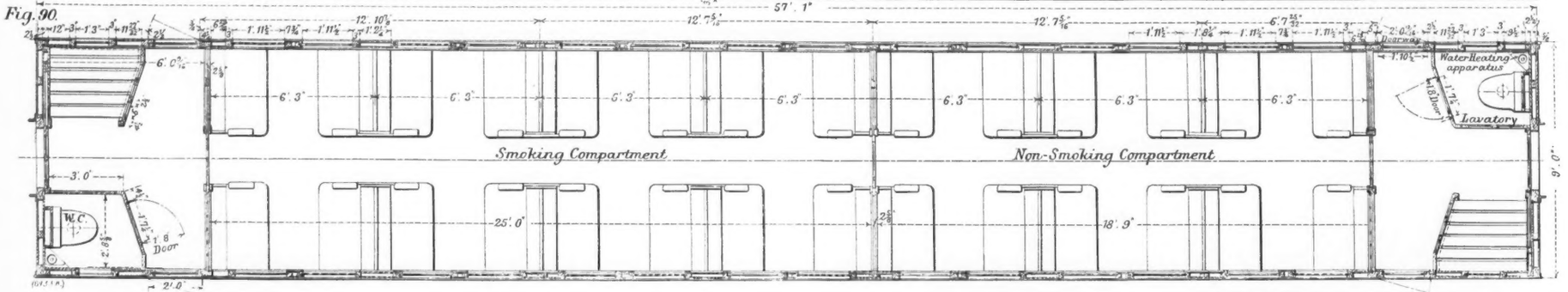


Fig. 91. LONGITUDINAL SECTION.

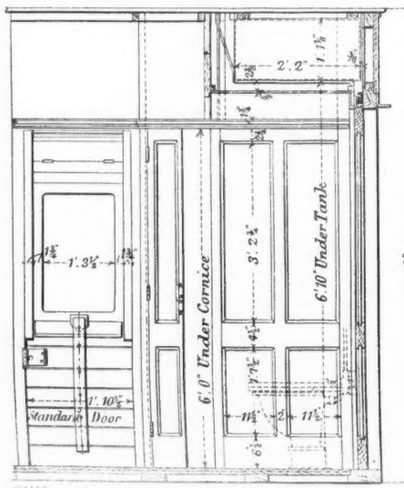


Fig. 92. HALF SEC. AT A.B. HALF SEC. AT C.D.

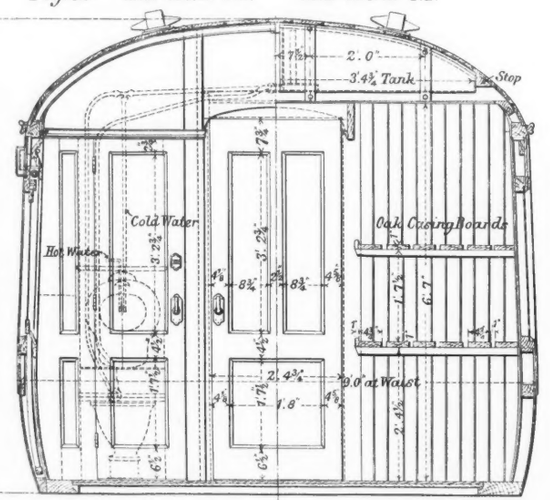


Fig. 93. SECTION AT E.F. THROUGH LAVATORY.

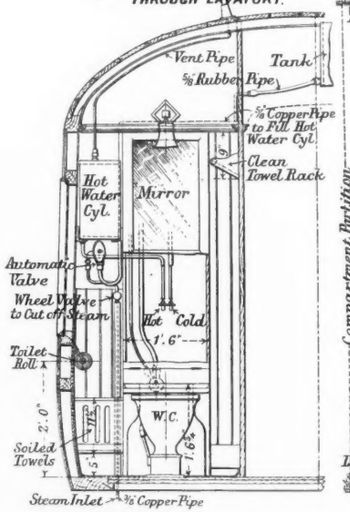


Fig. 94. PLAN.

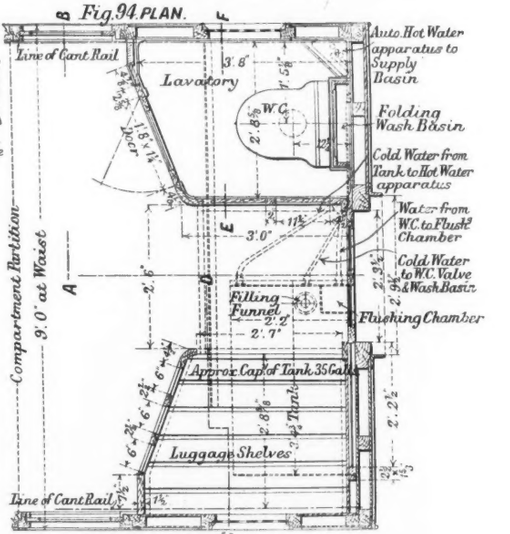
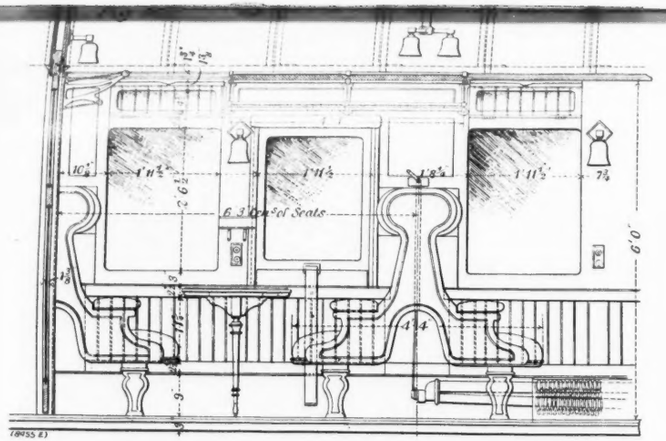

Line of Cant Rail
Lavatory
W.C.
Auto. Hot Water apparatus to Supply Basin
Folding Wash Basin
Cold Water from Tank to Hot Water apparatus
Water from W.C. to Flush Chamber
Cold Water to W.C. Valve & Wash Basin
Filling Funnel
Flushing Chamber
Approx. Cap. of Tank 35 Gals.
Luggage Shelves
Compartment Partition
9'. 0" at Waist

Fig. 97.



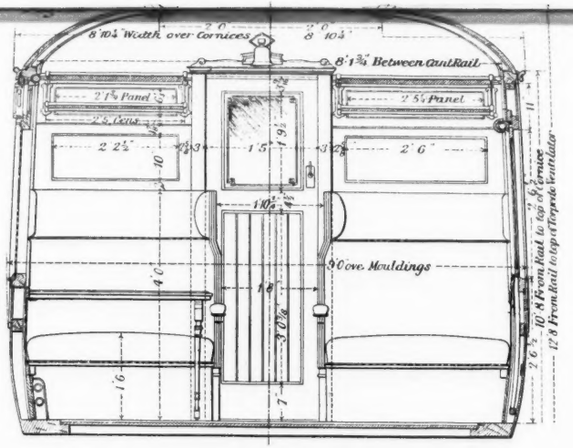

8'10¼" Width over Cornices
8'1¾" Between Cant Rail
2'1¾" Panel
2'5¼" Panel
3'0" ove. Mouldings
10'8" From Rail to top of Cornice
12'8" From Rail to top of Torpedo Ventilator

Fig. 97.

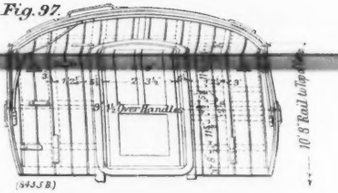


Fig. 98. SECTION THROUGH HEAD OF SLIDING DOOR.

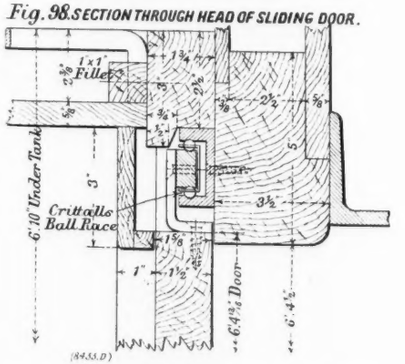


Fig. 99

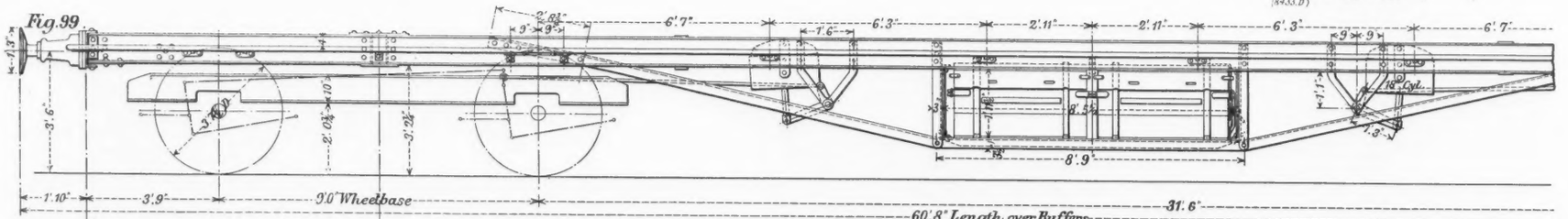


Fig. 100.

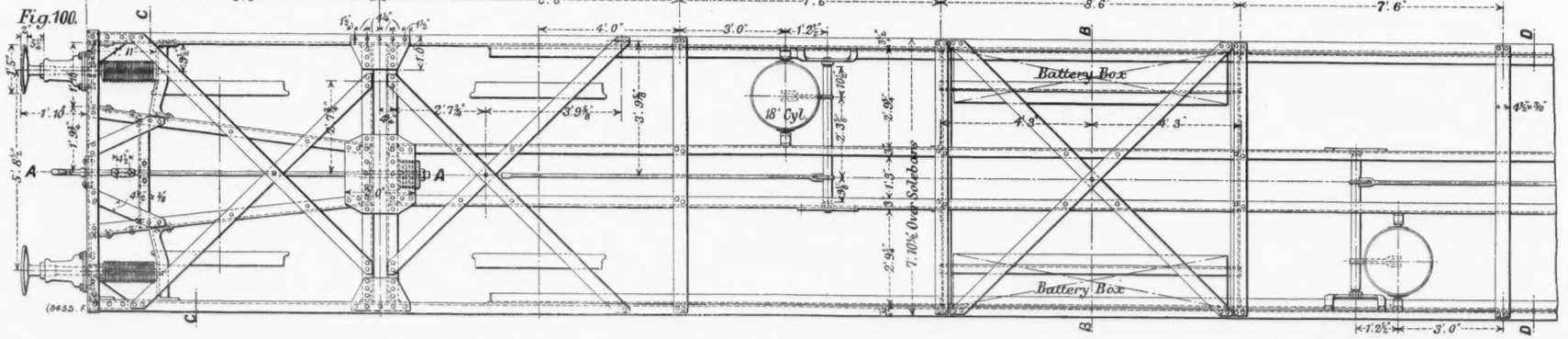


Fig. 101. SECTION A.A.

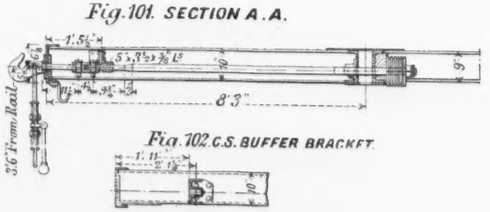


Fig. 102. C.S. BUFFER BRACKET.

Fig. 103. SECTION B.B.

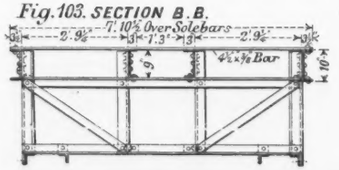


Fig. 104. SECTION C.C.

Fig. 105. SECTION D.D.

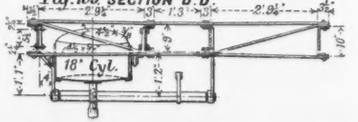
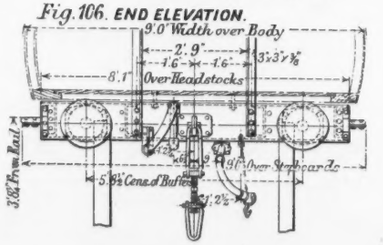


Fig. 106. END ELEVATION.



ENGINEERING.

Offices for Publication and Advertisements, 35 and 36, Bedford Street, Strand, London, W.C.2.

We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.

TELEPHONE NUMBERS—3663 and 8598 GERRARD.

SUBSCRIPTIONS, HOME AND FOREIGN.

"ENGINEERING" may be ordered from any newsagent in town and country and at railway bookstalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months, payable in advance :—

For the United Kingdom	£3	5	0
For Canada—			
Thin paper copies	£2	18	6
Thick paper copies	£3	3	0
For all other places abroad—			
Thin paper copies	£3	3	0
Thick paper copies	£3	7	6

Foreign and Colonial subscribers receiving incomplete copies through newsagents are requested to communicate the fact to the Publisher, together with the agent's name and address.

When foreign subscriptions are sent by Post Office Orders, advice should be sent to the Publisher.

ADVERTISEMENT RATES.

The charge for advertisements classified under the Headings of Appointments Open, Situations Wanted, Tenders, &c., is four shilings for the first four lines, or under, and one shilling per line up to one inch. The line averages seven words. When an advertisement measures an inch or more the charge is 12*s.* per inch. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity of going to press early with a portion of the edition, alterations for standing advertisements should be received 10 days previous to the day of publication.

All accounts are payable to ENGINEERING, LTD. Cheques should be crossed "The National Provincial Bank, Limited, Charing Cross Branch." Post-Office Orders should be made payable at Bedford Street, Strand, W.C.2.

AGENTS FOR "ENGINEERING."

AUSTRALIA : Gordon and Gotch, Limited, Melbourne ; Sydney ; Brisbane ; Perth. Angus and Robertson, Limited, Sydney, N.S.W. T. Willimett and Co., Townsville, North Queensland. W. C. Rigby, Adelaide, South Australia. Melville and Mullen, Melbourne, Victoria.

BELGIUM, Brussels : E. F. Satchell, 86, Rue du Tabellion.

CANADA, Toronto, Ont. : Wm. Dawson and Sons, Limited, 87, Queen Street, East.

EDINBURGH : John Menzies and Co., Limited, Rose-street.

FRANCE, Paris : Boyveau and Chevillet, 22, Rue de la Banque For Advertisements, Office de Publications Commerciales 167 Rue Montmartre, Paris (2e).

GERMANY : Hermann H. Fromm, Potsdamerstr 105A, Berlin, W. 35. A Twietmeyer, Leipzig.

GLASGOW : William Love, 221, Argyle-street. John Menzies and Co., Limited, West Nile-street.

INDIA, Calcutta : Thacker, Spink and Co., Bombay ; Thacker and Co., Limited.

ITALY : U. Hoepli, Milan. Anonima Libraria Italiana, Torino And any post office.

LIVERPOOL : Mrs. Taylor, Landing Stages.

MANCHESTER : John Heywood, 143, Deansgate.

NEW ZEALAND : Gordon and Gotch Proprietary, Limited, Wellington, Auckland and Christchurch.

NORWAY, Christiania Cammermeyer's Boghandel, Carl Johans Gade, 41 and 43.

ROTTERDAM : H. A. Kramer and Son, Limited.

SOUTH AFRICA : Central News Agency, Limited, Head Office—Johannesburg ; and Pretoria, Cape Town, Port Elizabeth, Bloemfontein, Durban, and various branches and bookstalls throughout South Africa. Wm. Dawson and Sons (South Africa), Limited, 29, Long-street, Capetown.

TASMANIA : Gordon & Gotch Prop'ty, Ltd., Launceston : Hobart

UNITED STATES : For Subscription, New York : W. H. Wiley 440, Fourth Avenue. For Advertisements : J. S. Allan 30, Church-street, New York.

CONTENTS.

	PAGE
A Rational Form of Draft Tube for Water-Turbines (*Illus.*)	153
Fire Protection Service at the British Empire Exhibition.—I (*Illus.*)	153
Stresses Due to a Loaded Surface when Earth is Treated as an Elastic Solid (*Illus.*)	156
The Colliery at the British Empire Exhibition (*Illus.*)	159
British Empire Exhibition : Railway Material.—V (*Illus.*)	160
1½-Ton Electric Overhead Travelling Crane with Underslung Bridge (*Illus.*)	164
Letters to the Editor.—"The Training of Engineering Teachers"	166
Fire-Resisting Bitumen	166
Notes from South Yorkshire	167
Notes from Cleveland and the Northern Counties	167
Notes from the North	167
Notes from the South-West	167
The Sydney Harbour Bridge	169
Coast Defence	170
The London Electricity District	171
Notes	171
South Africa at the British Empire Exhibition (*Illus.*)	172
The Exploitation of an Ulster Coalfield	175
International Commission on Illumination	175
Industrial Notes	176
Yarrow Boilers at Londonderry Power Station (*Illus.*)	177
Calcutta Water Supply	178
Extra High-Pressure Steam Turbines	178
The "Broomaster" Portable Air Compressor (*Illus.*)	179
Switchgear and Induction Regulators (*Illus.*)	180
High-Pressure Water-Tube Boilers (*Illus.*)	181
Royal Meteorological Society	181
The Thomas Gas Meter (*Illus.*)	182
Historical Note on the Kaplan Turbine (*Illus.*)	183
Catalogues	183
ENGINEERING Patent Record (*Illus.*)	184

Two-Page Plate.—L.M.S. RAILWAY THIRD CLASS VESTIBULE CAR AT THE BRITISH EMPIRE EXHIBITION.

ENGINEERING.

FRIDAY, AUGUST 1, 1924.

THE SYDNEY HARBOUR BRIDGE.

De gustibus non est disputandum is an ancient and generally acceptable adage, but the maxim is not one for all times and seasons. There are occasions when it is not only legitimate, but highly desirable, that matters of taste should be debated. Questions of this kind are bound to arise when works are to be undertaken which will serve not merely the present, but probably many, succeeding generations. Our own self-respect is involved in this, since scientifically and mechanically our successors are bound to be our superiors, but in the realm of art there is no reason why we should not equal the best to be accomplished by even the most remote of our descendants. It is thus most desirable that when monumental structures are to be erected, æsthetic considerations should be thoroughly considered, and it is no longer allowable to dismiss inartistic proposals with the trite, but often untrue, observation that argument on matters of taste is impossible.

In our last issue we gave particulars of the various proposals made for the great bridge across Sydney Harbour. This will have a span of 1,650 ft., and the structure ought to embody not merely the best of which the present generation is capable in the way of structural engineering, but ought also to be a permanent monument to our good taste. Those who have studied the designs submitted must have been struck by the fact that practically the same designs were submitted by more than one of the tenderers. The explanation lies in the fact that these reproduce in essentials the "official designs," which were issued at the same time as the specifications. Quite naturally the successful tenderers included also proposals for structures differing æsthetically from that selected by Mr. J. C. Bradfield, M.Inst.C.E., the chief engineer, who, perhaps, was swayed sub-consciously by some sort of paternal affection for the official designs.

Mr. Bradfield's report is excellent on the technical side, but we find ourselves in disagreement with many of his observations on the artistic merits of the various designs submitted. Naturally, this is a matter of taste, and we not propose to assert that our own views are superior to Mr. Bradfield's, but there do appear to be certain features in the recommended design, as to which reasoned criticism is possible.

It is a recognised maxim in all structural design that function should govern form and not *vice versa*. Now, a reference to Fig. 3, page 130, *ante*, shows that the form selected for the arch is that appropriate to the type which is fixed at the abutments, and not that characteristic of a two-hinged structure. The educated observer viewing the bridge from a distance would quite naturally conclude that the arch was fixed at the springings and would then be pained by the obvious inadequacy of the towers shown, to withstand such strains as might be imposed by an arch of this "rigid" type. The towers look as if they would be overturned, since in a rigid arch the line of resultant thrust would be situated far above the level of the hinge actually used. In this regard the alternative design submitted by the successful tenderers and reproduced in Fig. 2 is, we think, superior to the accepted design, the apparent abutment being less obviously unequal to the thrust suggested by the form of the arch. As already indicated, however, appearances are in this instance deceptive, and the arch is really a two-hinged one, but we think it can hardly be denied that it is an artistic error to give it a misleading outline.

There is, however, in our opinion another æsthetic fault embodied in the official design. "Even a joke should have a meaning," observed the Red Queen to Alice in her looking-glass Adventures, and we may paraphrase her majesty's concluding words by asserting "that a tower is more important than a joke." It would, however, require an ingenuity rivalling in quality that of the White Knight to find any meaning for the two enormous and expensive towers embodied in the accepted design. The towers, in fact, have no structural significance whatever. They are merely enormous aggregations of granite and concrete, forming no integral part of the structure, and put in merely with a view to "architectural effect." Architects, however, are not good guides in the matter of steel work design. As the history of building shows, the architects of each age in which structural materials have changed have invariably long adhered to traditions inherited from the prior state of the constructional arts, and reproduced, say, in stone, features and details, which arose naturally and quite appropriately in the previous use, perhaps, of timber. In regard to steel bridges, the architect has not yet learnt to discard traditions inherited from the "Stone Age," and in fact has had little opportunity of doing so, since it is his practice to transfer to the engineer the design of all steel work which presents any special difficulty. "Lie heavy on him, earth, for he laid many a heavy load on thee," was the epitaph suggested for Vanbrugh, and the subsoil of Sydney Harbour might well echo the sentiment so far as this mass of meaningless masonry is concerned.

Of course, only a very few engineers in each generation are gifted with that inherent sense for form which is the distinguishing mark of the supreme artist ; but credit for some touch of this constructional instinct seems due to whoever was responsible for the design reproduced in Fig. 4, page 130 *ante*, which Messrs. Dorman Long and Company submitted as an alternative to the "official design." Every detail here has structural significance, with the result that a bridge artistically satisfactory has been designed. It is noteworthy that this design in which function has governed form is not merely more pleasing to the eye, but would cost nearly half a million less than the accepted plan. Mr. Bradfield condemns this alternative as æsthetically inferior to the official type, but in this judgment we cannot follow him. It is somewhat surprising that the estimated weight of the steel for this "cantilever arch" is greater than for the

two-hinged arch. Possibly this is due to the provision made for temperature stresses, but it is quite usual, and experience seems to indicate, quite legitimate to use a smaller factor of safety for these very occasional and very slowly applied stresses than for those due directly to the loading. The chief engineer also seems to consider the "official" cantilever design, which was of the general type represented by Figs. 11 and 16, page 131 as æsthetically superior to the alternative suggested in Fig. 13. For our part, we prefer this to the "official" type, but, unlike the "official" arch bridge, the "official" cantilever design is a natural structure, and the choice between it and the proposed alternative becomes therefore a mere matter of personal predilection, and opinions as to relative artistic values may fairly differ.

As already mentioned, the technical part of Mr. Bradfield's report appears to be eminently judicial, but he is perhaps a little too trenchant in his condemnation of the working stresses which Sir William Arrol and Co. proposed to adopt for the special steel to be used for their designs.

It requires some boldness to state definitely that these stresses are excessive, since they were recommended by very experienced engineers. As a matter of fact we suspect that Mr. Bradfield has based his criticism on the assumption that the "limit of proportionality" of the steel in question was comparable with the "works" elastic limit of nickel steel on which he would accept the stresses suggested. The "works" elastic limit is the yield point which is, of course, commonly very materially higher than the "limit of proportionality." In any case the elastic limit of a steel seems to have little relationship to its structural value, and it is for this reason that all mention of it is, of set purpose, excluded from the specifications for ship-building steels, prepared by the British Engineering Standards Committee.

The proposed bridge is a very important structure indeed. The span (1,650 ft.) approximates to that of the Forth and Quebec bridges, and the structure will be the longest arched span in the world. The load to be carried is very heavy. Accommodation has to be provided for a central roadway 57 ft. wide between the kerbs, and on each side of this there will be two railway tracks, and beyond these a footway 10 ft. wide. The main ribs are spaced 98 ft. 6 in. centre to centre, but the total length of the cross girders will be 158 ft., the outer railway tracks and the footways being supported cantilever fashion. The type of structure was partly chosen because it permitted better rail approaches than either the suspension bridge or cantilever designs. With the arch the sharpest curve will be of 1,200-ft. radius, whilst with the suspension type the provision of anchorages would make it necessary to adopt approach curves of as little as 500-ft. radius. The arch structure again is very rigid, and on this factor Mr. Bradfield quite rightly lays great stress. In the case of the selected design the maximum deflection due to combined live load and temperature stresses will be only some 11 in., whilst the corresponding figure for one of the suspension bridges proposed exceeded 7 ft. Mr. Bradfield also points out that the arch type will distort relatively little under live loads unsymmetrically distributed.

About half the steel required will be obtained from Australian mills, and the bridge will be built in the new works which Messrs. Dorman, Long and Co. are constructing at Sydney. These new shops will be amongst the largest and best-equipped in existence. One shop will be 600 ft. long and 149 ft. wide between centres of crane rails, whilst a second of the same length will be 130 ft. wide between crane rails. Two of the electric overhead travelling cranes provided will be of 150 tons capacity.

In view of the present prevalence of unemployment it is, from our own standpoint, unfortunate that the work on this large contract will not be carried out at home. It is, however, very natural that the Commonwealth should desire the credit for the execution of this great project with its own labour, and as far as possible with its own resources, and probably the community would at need be prepared to effect this even if it involved some pecuniary sacrifice. Messrs. Dorman, Long and Co. have asked for the modification of some clauses in the contract to provide for labour troubles, possible shortage of material, and tariff difficulties which might arise in connection with the imported material. They also ask for better facilities for acquiring temporarily the lands necessary for the works. In all these matters the chief engineer seems to have met the requests in an exceedingly reasonable way.

COAST DEFENCE.

By a singular chance, the problems of coast defence have been examined almost simultaneously in Washington and Paris. Recently the committee on naval affairs in the American House of Representatives considered a proposal to buy land for a naval air station on the coast of Washington. The discussion of this comparatively insignificant item on the agenda led the committee to a question of far greater importance: If the coasts of the United States are attacked, what share in the defence falls to the navy and what to the army? Highly placed officers in both services were called before the committee and examined, and though the discussion was long, rambling and incoherent, and reported in complicated language, it sufficed to show that the American high command has organised its coastal defence on certain well-tried principles. The French parliament, on the other hand, was not led to the problems of coast defence by questions of another kind. The matter has been explicitly studied by a committee of 40 deputies, and reported on by Monsieur Georges Boussenot with the precision of thought and language for which his countrymen are justly famous.

The American system of coast defence is, evidently, that the navy shall deal with the floating, mobile forces of an attacking group; but that the army shall have charge of all fixed fortifications ashore, whether they protect naval establishments or not. This, at all events, is the meaning which would ordinarily be given to Admiral Moffet's statement: "It is admitted by all that the first line of defence is the main fleet; that the second line of defence would be the auxiliary vessels of the fleet . . . and that the third line of defence is our coastal fortifications."

The system which the French commissioners recommend is very different. In their opinion, the naval command must control both the mobile defence afloat and the fixed defences ashore, and they have added a historical review of the whole question to support their conclusions. For centuries the coastguard militia (*milices garde côtes*) and the local admiral were responsible for the defence of the French coasts; but in 1759 the duty of protecting the "sea frontiers and fortified naval bases" was transferred to the army. It is open to argument whether this arrangement was theoretically correct or not; but it is beyond all question that the high military authorities, being perpetually occupied with continental campaigns, utterly neglected the coastal defences of the country. The administrative change of 1759 has been much criticised; commission after commission has studied the question; and the *projet de loi* is, as the commissioners explain, intended to close a controversy which is more than a century old.

The commissioners think that the French coasts may be attacked in four different ways: (1) they may be bombarded by light forces assisted by bombing and spotting aeroplanes; (2) they may be attacked by submarines of the 1600-ton type armed with 10-in. or 12-in. guns, also assisted by spotting aeroplanes; (3) the entrances to the war harbours may be blocked; and (4) landings in force may be carried out at points of industrial or naval importance. The first three forms of attack require no explanation, but the fourth must be examined rather closely if the report of the commission is to be understood.

When a country's neighbours have such a naval superiority over her that they dominate her sea communications, then, in theory at least, that country can be invaded from the sea. The commissioners are, however, careful to say, that, in their opinion, France's present naval weakness does not expose her to a danger of the kind. For reasons which they have not given, they express themselves convinced that France cannot be invaded from the sea, in the strict sense of the word; but they define the dangers to which their coasts are exposed very explicitly: "It can hardly be assumed that a real, invading army will attack our coasts; but it would be most unwise to say that landing operations with a limited military or political object are impossible. . . . The islands off our coasts, and our colonial possessions are very vulnerable points. Their loss might hamper our naval operations most seriously, and it is our duty to do everything in our power to protect them adequately. Rapid strokes by a force of from three to four battalions against important coastal points such as aerodromes, industries, and shipyards are quite feasible operations, if prepared carefully and carried through with the necessary energy. Their consequences might be of the utmost gravity, and one would be singularly lacking in judgment and imagination if one ignored the possibility."

Attacks of this kind will be met by coastal artillery of all calibres, anti-aircraft guns, and obstructions such as minefields and explosive barrages in the first place; and, in the second, by surface and submarine flotillas and the coast defence air force. The commissioners have taken the strictly logical view that these fixed and mobile defences ought not to be under a divided command; and that all means of resisting an attack from the sea should be organised and set in motion by the local naval commander.

This is the exact opposite of our practice, and, as far as can be seen, of the American system as well. Our rule of command, in such cases, is that a naval officer is in sole charge at sea, and an army officer acts equally independently on land. It is worth while to examine the reasons behind opposing systems. If a country has a powerful surface fleet its coastal defence measures differ radically from those of a country with an indifferent navy. In the first case, attacks are dealt with by confronting the attacking naval force by another so powerful that all attempts against the coast have to be broken off. Armed landings are disposed of by cutting the communications of the landing force, that is, by sinking its transports, and driving off its naval supports. This system makes the shore defences relatively independent of the naval command. The naval forces detailed to oppose a coastal attack, or an armed landing, are but little concerned with the amount of resistance which is put up by the shore, as their sole preoccupation is to bring the attacking squadrons to action. The attack may be dealt with before or after it has been delivered, by an engagement fought many miles away from the bombarded town, or the place of the landing. The test of a successful resistance is always that the attacking force has not been allowed to complete its operations unfought. The British and American high commands can assume that their naval power will always suffice to deal with coastal attacks by this method, and have laid their defence plans accordingly.

To a country like France the problem is quite different. Her naval weakness obliges her to deal with coastal attacks *in situ*; as she cannot defeat or disperse them by a purely naval counter attack; and the commissioners find it unreasonable to divide the forces upon whom the duty of resistance falls, between two separate commands. The scouting aeroplanes, the submarines, the minelayers, the destroyers, the shore batteries and their supporting troops are, therefore, all placed at the disposal of the naval commanders-in-chief of the maritime frontiers.

The report of M. Georges Boussenot and the commissioners deal with principles only; but it contains one instructive passage upon the kind of material which will be used in French coastal defence. "Batteries of light, very rapid firing, artillery are indispensable for defending nets and obstructions at the entrances of large defended harbours; they alone are capable of stopping attempts made by light craft or by engines controlled by hertzian waves. Medium calibred artillery (5·5 in. to 6·2 in.) is the only efficient means of defence against night bombardments by light cruisers and destroyers . . . and every one of our large naval or commercial ports should be defended by at least two or three batteries of heavy

guns (11·8 in. to 13·4 in.)." Certain theorists have objected that a coast can be bombarded from a distance of 20 miles by naval artillery directed from aeroplanes. The answer to the criticism is simple. "If a monitor can bombard a heavy battery from a distance of 40 kilometres, is it reasonable to allow her to come closer in and so make her bombardment more accurate and telling, by suppressing the heavy batteries which force her to operate at extreme range?"

The French naval command has lost no time in training their squadrons and personnel in the problems which the Chamber of Deputies has been examining. During the last days of March vice-admiral Docteur, with the Diderot and nine destroyers, and a considerable military force, attempted a surprise landing near Lorient. It was opposed by vice-admiral Jehenne, the commander-in-chief of the maritime frontier, who had a considerable force of infantry and artillery placed under his orders. The results of the exercise are, of course, kept secret; but it is evident that the attack, and the method of warding it off, were both inspired by the *projet de loi sur l'organisation et la défense des frontières maritimes*, which was the subject matter of M. Boussenot's able and instructive report.

THE LONDON ELECTRICITY DISTRICT.

THOSE enthusiasts, political and otherwise, who have not yet ceased to deal in generalities about the beneficent effect of wholesale electrification, and who light-heartedly and sometimes light-headedly, talk of grandiose schemes covering the whole country might with profit study the Order "constituting the London and Home Counties Electricity District and establishing and incorporating the London and Home Counties Joint Electricity Authority," which has just been made by the Electricity Commissioners. It is easy to talk in vague terms about the advantages of generating in large stations and distributing from a unified system over large areas, but when a real attempt is made to deal with the question of unification in practical terms, difficulties are found to crop up at every turn, and the ablest statemanship and most untiring effort will at the end be found to lead to something much more modest than the rosy but formless visions of which electrical work has to such an unfortunate extent been made the victim.

In the third clause of the new Order it is stated that "the scheme set out . . . shall apply and have effect, and the London and Home Counties Electricity District shall be and is hereby finally determined and the London and Home Counties Joint Electricity Authority shall be and is hereby established and incorporated." These are brave words which we hope may prove justified, but as has been the case throughout the whole story of the long attempt to overhaul the electricity supply of London, there are still obstacles to overcome. This new scheme, which has been reached only after years of negotiation and discussion, is even now dependent on two bills getting through Parliament, and if in their passage through that assembly the agreements with which the bills are concerned are modified, then the whole scheme and the arrangements of which it is based "shall be void and of no effect." There is no profit in anticipating troubles which may never arise, but one cannot lose sight of the fact that these bills form an opportunity for a further mobilization of the forces, which are so convinced of the value of great extensions of electrification in London that they have up to the present been able to prevent any start towards such extensions being made on the modest lines which only are practicable. The Order assumes the passage of the bills to which we have referred in the Session of 1924 or 1925, and while it is not satisfactory that consideration of the bills has been postponed to at least the end of the present session, it is some comfort that more than a year is yet available in which to get the matter through.

As will be generally known there has for a considerable time past been no difficulty about fairly general agreement on the engineering features of a scheme of unification for the electricity supply of London. Administration is, and essentially always has been, the difficulty. The area covered by the District extends from St. Albans to Reigate and from Windsor to Gravesend, and there is no difficulty in realising that the authorities concerned and the conflicting interest in such an aggregate of towns and districts have made the formulation of a generally acceptable scheme of enormous difficulty. As we have said, however, the difficulty is not a technical one. A single ably administered authority could handle the whole of the electricity supply in this area with profit to itself and with general satisfaction to the public. Such a single authority however, is not within the realm of practice, and the Commissioners have had to content themselves with a compromise.

Briefly, the proposed arrangement is a Joint Electricity Authority, consisting of 31 members appointed or elected by local authority undertakers, company undertakers, the four power companies concerned, the County Councils, workers in the industry and railway companies. This body will administer the technical scheme and take charge of supply as a whole, but for very many years will not necessarily itself become a producer of electricity. The authority will have power to purchase generating stations and main transmission lines, and it may be that negotiation will lead to the exercise of such rights at an early date, but it is impossible to say in exactly what direction matters will develop. The question of the relation between public authorities and the London supply companies has been met by the Bills now before Parliament, to which we have already referred. The companies have split themselves up into two groups. One which is conveniently referred to as the Ten Companies consists of the Brompton and Kensington, the Charing Cross, the Chelsea, the Kensington and Knightsbridge, the Notting Hill, the St. James's and Pall Mall and the Westminster supply companies, with the London Electric Supply Corporation, the Metropolitan Company and the Central Electric Supply Company. The other group—the Four Companies—consists of the City of London Electric Lighting Company, the County of London Electric Supply Company, the South London Electric Supply Corporation and the South Metropolitan Electric Light and Power Company.

At the present time the London County Council has the right to purchase the business of the majority of these companies in 1931 and in every subsequent tenth year, while the City of London has the right to purchase part of the Charing Cross Companies' undertaking in 1927, and the Borough of Lambeth has rights of purchase over part of the London Electric Supply Corporation's undertaking which are exercisable until 1928, and the Borough of Camberwell has similar rights in connection with part of the County of London Company's area. The main purpose of the Bills before Parliament are to extinguish these rights of purchase and to substitute for them an undertaking that the material covered by them shall be transferred to the new Joint Electricity Authority on December 31, 1971. In addition, the companies will accept a sliding scale making dividend paid dependant upon the price at which electricity is sold, and will co-operate with the Joint Authority in its scheme of reorganisation of the electricity supply of Greater London. The two company groups also seek powers to work together each as a single organisation. They are to start sinking funds which will automatically extinguish their capital by the time the property is transferred to the Joint Authority.

The technical scheme, which the Joint Authority is to administer, selects certain stations as principal generating stations, which will be extended in the future as conditions dictate, and which may be looked upon as the essential points at which it is considered great plant capacities may profitably be placed in the future. Four such stations are selected: Stepney, owned by the Stepney Borough Council; Bankside, owned by the City of London Company; Barking, the new station of the County Company, which is not yet in operation; and Deptford, the main station of the London Electric Supply Corporation. In addition, thirteen stations are scheduled as suitable for extension under the scheme, but not as being regarded as principal stations. Some of these are large and important, and the section covers, for instance, Hackney, St. Marylebone, Bow and Grove Road. This section covers some smaller outlying stations, such as those at Guildford and Sevenoaks, from which it may be concluded that the Commissioners do not anticipate any very immediate closing down of all small stations and the running of main transmission lines, fed from principal stations, over the whole area. In this they are unquestionably right. Time and future development may prove that seventeen stations is too many for the area, but if they do the matter may well be left to be dealt with when it arises. A further section covers forty-four stations, which are to continue to operate, and may even be extended if the Commissioners find it desirable, but which, we take it, may ultimately be expected to be closed down or mainly converted into transforming stations.

It will be clear that no drastic attempt to close down stations wholesale or to build new capital stations is to be attempted. This is wise. Matters in a sense will continue working much as they are, but the whole area will be under observation and under some control from the Joint Authority, and the transmission lines which are to be undertaken as part of the scheme will unquestionably lead to the gradual shutting down of small or uneconomical stations. The whole scheme seems to cover a practicable method of making a real beginning on the complex problem of the electricity supply of London, and it is much to be hoped that the present Parliamentary bills may be passed substantially without change, and that the years of effort which have been expended on this question may at last begin to lead to some definite results.

NOTES.

THE ITALIAN SUBMARINES, CLASS "O."

IN the issue for May of the *Rivista Marittima*, Captain Vincenzo de Feo gives the following particulars of the Italian submarine of type "O," designed by the Società Ansaldo San Giorgio, Spezia:—

Length between perpendiculars.	73 m.	= 239 ft. 6 in.
Extreme breadth ...	6·25 m.	= 20 ft. 6 in.
Draught	4·61 m.	= 15 ft. 2 in.
Surface displacement ...	1,020 metric tons.	
Submerged displacement	1,280 „	„

The armament consists of eight 533 mm. (21 in.) torpedo-launching tubes, with eight torpedoes in the tubes and four in reserve; two 102 mm. (4 in.) 50 calibre guns and 450 rounds; and one 533 mm. mine-laying tube, with six mines in the tube and 12 in reserve. As an alternative, instead of two 102 mm. 50 calibre guns, there can be carried two 120 mm. (4¾ in.) shorter guns, and the mine-laying tube can be given a diameter of about 1 m. (39·37 in.) with eight mines in the tube and 16 in reserve, over and above the 12 torpedoes. Were the boat solely to be used as a submarine the number of torpedoes could be increased to 18; if it were solely to be used for mine-laying the number of mines could be increased to 54. The propelling machinery consists of two 2,500 h.p. oil engines. The normal quantity of oil carried is 70 metric tons, which could be increased to 141 tons. The two engines will give the boat a surface speed of 19 knots; the normal oil supply gives a radius of action of 1,200 miles, or double that radius of action with the increased amount of oil. The surface speed with one engine is 15·5 knots, and the radius of action 2,000 miles or 4,000 miles according to the quantity of oil carried. With one engine, the cruising speed would be 8 knots, and the radius of action 4,500 miles, or 9,000 miles. When submerged the submarine is propelled by two 1,100 h.p. electric motors, supplied with current from accumulators weighing 126 tons. The maximum speed submerged for one hour is 11 knots; the radius of action submerged, at a speed of 4 knots, is given as 110 miles. The normal buoyancy reserve is 25·5 per cent.; that with increased amount of oil fuel, 19 per cent. The surface stability, metacentric height, is 47·5 cm. (18⅝ in.) and when submerged 38 cm. (15 in.). The boat could be completely submerged in 30 seconds. The central part of the boat, 38 m. (124 ft. 8 in.) in length, is circular in section and 6·25 m. (20 ft. 6 in.) in maximum diameter. It is able to resist a pressure corresponding to a depth of 100 m. (328 ft.); the ends are not designed to withstand excessive pressure. The machinery and steering gear is in the central portion, which is divided into compartments by water-

tight bulkheads. The two end compartments serve as launching compartments and berths. The two ends of the boat are divided into flooding compartments. The pressure resisting portion of the submarine being limited to the centre and being about half the total length of the boat, the two ends alone being set apart for flooding, has led to a notable saving in the weight of the boat and has greatly simplified the internal arrangements. The essential mechanical parts being in the broadest portion of the boat, it has been possible to ensure easy operation and inspection.

Workmen's Compensation: A New Question.

When an employee is injured by an accident and compensation is claimed from his employer, under the Workmen's Compensation Acts, the first question which requires to be considered is, as a rule, whether the accident arose out of and in the course of the injured person's employment. The Court of Appeal had to consider a case a few days ago (Davis *v.* Gwauncaegurwen Colliery Company, Limited), in which the widow of a workman claimed compensation from his employers—a colliery company—in respect of an accident which caused his death. He was a screensman at a colliery and worked on the front part of the screens for loading railway wagons. The back part had been disused for some years, and the workman had no need to go to it; but he had been in the habit of going into it and hanging his coat up on a nail and later on going there to eat his food. The officials of the colliery knew that he did this, but he was the only man who did it. There were cabins provided for the men, in which he could have hung up his coat and left his food. A few days before the accident the company put up a barrier of railings to prevent anyone from going into the disused part, as it was considered to be dangerous; but apparently, notwithstanding the barrier and nothwithstanding a warning from the carpenter who erected it, the man continued to go to it. He arrived at the pit before daylight on February 13, and apparently fell down a hole 19 ft. deep in the disused part of the screens, and he died of injuries due to the fall. His coat was found hanging on the nail as usual. The County Court judge held that the accident did not arise out of and in the course of the man's employment, because his employment did not require him to go into the dangerous place, and he went there for his own purposes only. This, however, was not the only question which the County Court judge had to decide, because the claimant relied on Section 7 of the Workmen's Compensation Act, 1923, which is as follows: "For the purposes of the principal Act an accident resulting in the death or serious and permanent disablement of a workman shall be deemed to arise out of and in the course of his employment, notwithstanding that the workman was at the time when the accident happened acting in contravention of any statutory or other regulation applicable to his employment, or of any orders given by or on behalf of his employer, or that he was acting without instructions from his employer, if such act was done by the workman for the purposes of and in connection with his employer's trade or business." It was contended for the claimant that the case was covered by Section 7 of the Act of 1923. Presumably it was argued that although the man was acting without instructions from his employer his act was done for the purposes of and in connection with his employer's trade or business. The County Court judge decided that the workman was not doing anything in connection with or for the purposes of his employer's trade or business when he met with the accident, but was acting entirely for his own purposes, and that therefore compensation was not payable. The widow appealed, but the Court of Appeal agreed with the County Court judge. This was the first case brought under the new section.

Carbonisation of Seaweed.—The carbonisation of seaweed as a preliminary to the extraction of iodine and potassium salts forms the subject of the Technical Paper No. 9, issued by the Fuel Research Board. It can be obtained, at the price of 6*d.* net, from H.M. Stationery Office, Kingsway, London, W.C.2.

SOUTH AFRICA AT THE BRITISH EMPIRE EXHIBITION.

The South African Pavilion has been organised by the Union of South Africa, though it includes exhibits from Rhodesia, Swaziland, Tristan da Cunha and St. Helena. A plan of the pavilion is given in Fig. 1, opposite, and a general view of its frontage was given in our issue of April 25 (Plate XXXVI), but its design differs so characteristically from the British buildings and the pavilions of the other large Dominions that a more detailed view of a portion of the front is given in Fig. 2. The difference is, in fact, not immaterial to the meaning of the whole South African exhibit. The magnificent structures in which the products of this country and of the other large Dominions are housed are great halls, suitable for displaying any sort of contents. The South African Pavilion, on the other hand, is designed in the style, not of a hall or of a palace, but of a house. It has had, of course, to transcend the dimensions of any real house; but if the length of its frontage and depth—about 450 ft. by 170 ft.—were sufficiently reduced, the structure of the South African Pavilion would then be an enlarged copy of a characteristic type of Dutch South African home. This effect is carried out by the moderate height of the building, and the homeliness is increased by the orange and white screens that are stretched over the roof lights, and take off the glare of a summer sun, such as is more common in South Africa than here. The building stands in grounds laid out with a large collection of typical South African plants under the charge of an expert gardener from the country, also containing an ostrich paddock with a number of vigorous and handsome birds, sheep and goat houses, and a restaurant train, on which South African meals are served. At the back of the pavilion are two cinema theatres, devoted respectively to the industries of South Africa and to its history, scenery and facilities for travel.

The designers of the pavilion have, in fact, been at pains to reproduce South African surroundings in every detail that is possible. Their purpose is expressly to use the Exhibition as a means not merely nor even so much of displaying their products and manufactures, as of making visitors better informed than they are of what life is in South Africa; what it can produce, the circumstances in which its population are working, and the advantages it offers to those who may visit or settle in it. Other Dominions have had a similar purpose in view, but probably none has so strong a reason. The industrial outlook, both for South Africans and for those who wish to do business with them, is related so intimately to this reason that, before describing the individual exhibits which are likely to be of special interest to our readers, it is desirable shortly to outline the position of the Dominion, and its special reason for expressing itself at Wembley in the form of a home.

The area of the Union of South Africa—for the present purpose it is best to speak in round figures—is some 473,000 square miles, and its population some 7,000,000 souls. The extreme North of the Transvaal is within the tropic of Capricorn, and about one-third of the whole area of the Union may be regarded as lying within tropical latitudes. Taking a line across the country from Capetown at the South West to Johannesburg towards the North East, the mean daily sunshine is from two-thirds to over three-fourths of the total possible number of hours, as against less than one-third for London and less than two-thirds for Calcutta. But while the climate thus has the advantage of tropical sunshine, the elevation of the country spares it for the most part a tropical temperature. Its mean elevation is, in fact, twice as great as that of Australia, and one-third higher than that of North and South America. Except for narrow belts near the Coast, no part of it is less than 1,000 ft. above sea level and more than two-fifths of it is over 4,000 ft., while there are no great mountain ranges, and the shape of the sub-Continent gives it a long coast-line relatively to its area. These circumstances combine to give the Union a considerably lower temperature than would be felt in the same latitudes at the sea level, and to make it uniform to a remarkable degree over the entire country.

To some extent, therefore, the country combines the advantages of tropical with those of sub-tropical or temperate climates, and is particularly healthy for Europeans, the mean crude death-rate being about 15 per cent. lower than that of England and Wales. It is, in fact, eminently a white man's country; yet of the total population of the Union only about a fifth are white. Over half of these, moreover, are in urban districts; in the rural districts little more than one-eighth of the population is white; and, taken over all, there are about three white persons to the square mile throughout the Union. The density is extremely variable. In Johannesburg and Durban it is three times as great as the average of the United Kingdom, with almost as many white as coloured.

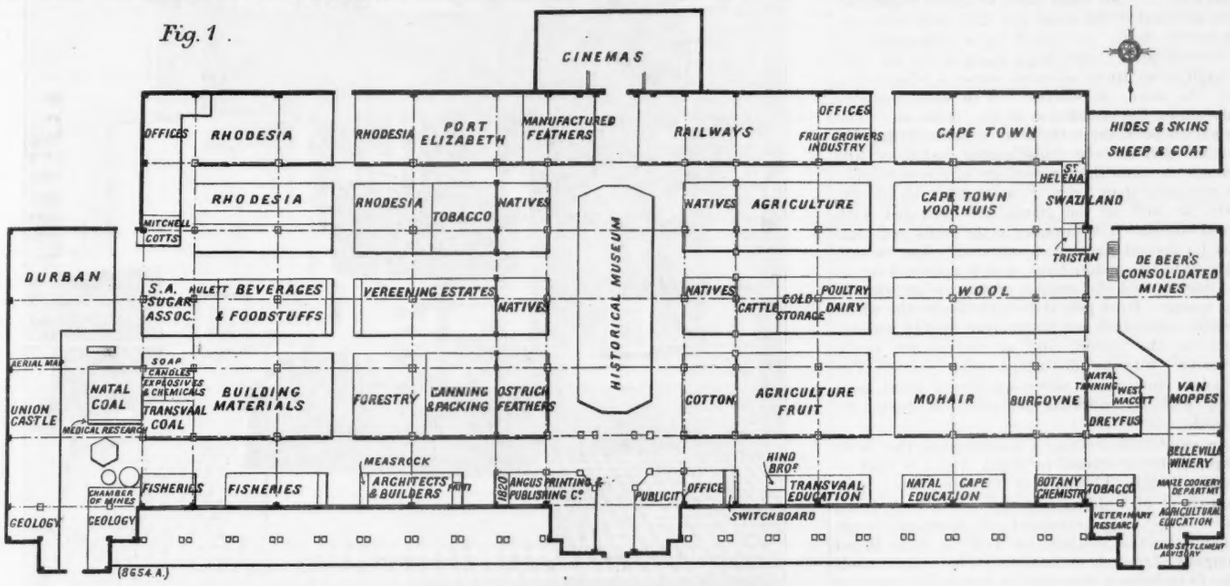
The community of the Union furnishes, indeed, an instance that is probably without parallel in modern times, of an extensive white settlement having organised a great native territory in such a way that the natives have not died nor been squeezed out, as has happened in similar circumstances elsewhere, but have flourished and increased side by side with the civilised immigrants. So long as the whites continue to predominate, this symbiosis is eminently to the advantage of all the races in the State, and allows the civilised customs of the dominant race to be maintained. The maintenance of these customs is, however, of vital importance to the suitability of the country for immigration from home, and even graver questions might arise should the white races remain in their present minority. The native population as a whole is contented, tractable and intelligent. An interesting part of the exhibits of the Union displays historical features of the country with rock engravings and carvings, weapons and even tools, made by the natives before the European immigration. Fig. 3, for example, shows bellows used habitually by two tribes for smelting and forging iron and some tools made with its help. Side by side with copper anklets weighing 12½ lb. each, which are among the most precious possessions of persons of really aristocratic birth, are native works of art and other products showing taste and ingenuity; and, in addition to 100 exhibits of this sort, a still larger number of photographs are shown by Mr. A. M. Cronin, of natives following their own practices according to their old traditions. With these traditions and with the influence of mission schools and other educational agencies, the inborn intelligence of the natives is being cultivated. The progress they make is of advantage to themselves and to the many industries for which they provide suitable labour. If, however, the vast forces that they represent are to be turned to the benefit of the Union, and indeed not to be a danger both to themselves and to the white community, the increase of the population by the addition in large numbers of suitable immigrants is indispensably necessary.

The chief purpose of South Africa's vigorous participation in the British Empire Exhibition is to stimulate this immigration. From Fig. 1 it will be seen that a relatively small part of the exhibits are supplied by individual firms, the large majority being provided by Government or communal authorities and by a few great groups. It is significant that on entering by the main entrance the visitor is faced with the largest single stand in the pavilion, devoted to the fauna and history of the country, and has to the right and left of him the sections of publicity and of a bureau representing the South African press, while many stands in various parts of the building are devoted to showing the facilities for education and research of various kinds, and the results that have been obtained by their help. The publicity section indeed is by itself something approaching a complete library on the subject of the Union.* It contains an admirable catalogue, which will be of great help to those whom the pavilion has interested

* An excellent summary of much of this information, with similar particulars regarding South West Africa, North and South Rhodesia, and Portuguese East Africa, is to be found in the illustrated Handbook to the Trade, Industries, Products and Resources of South Africa and adjacent territories by Mr. C. W. Francis Harrison. (Arthur's Press, Woodchester, Gloucester). [22*s.* post free.] A new edition of this work has just appeared.

and seems only to lack a map and a somewhat more detailed index. The intention of the Exhibition is illustrated further by the several towns—Capetown, Durban and Port Elizabeth—that give large separate exhibits devoted specially to their own cities. Thus Capetown has erected a striking reproduction of the front hall of an old Cape house, with furniture and brass furnishings copied from what was usual in the better homesteads of the old Dutch settlers, and some hundreds of exhibits that include lantern slides and paintings of Cape

Fig. 1.



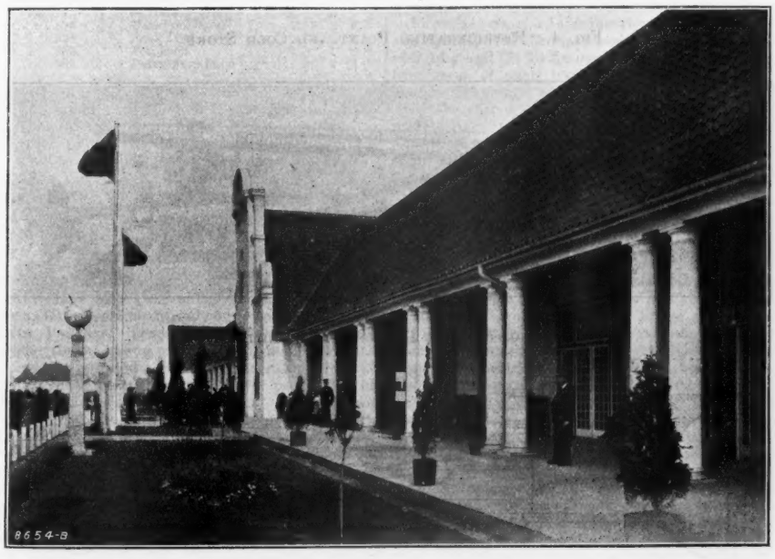


FIG. 2. THE PAVILION.

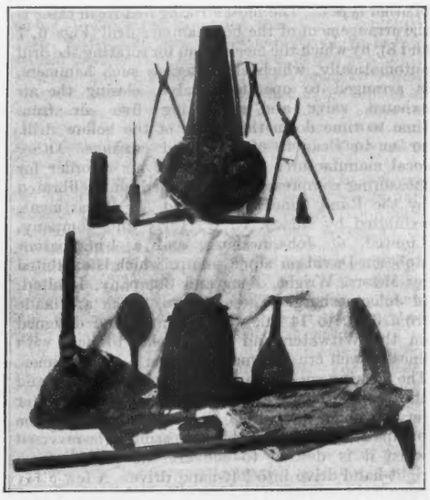


FIG. 3. NATIVE MINING IMPLEMENTS.

wild flowers. The Durban exhibit consists of three fine models. One, on a scale of 100 ft. to the inch, shows the harbour and town, exhibiting the remarkable facilities of the harbour. With an area of 7¼ square miles and (including the repairing quay and jetties) over 3 miles of wharfs, it can berth vessels up to 22,000 tons, or 90 vessels of average size at one time. It has over eight million cub. ft. of wharf shed accommodation, hydraulic cranes up to 50 tons, a 15-ton floating crane, and 24 hydraulic and electric wharf capstans. There is a floating dock with a lifting capacity of 6,500 tons, and near the entrance to the harbour a large coaling station with bins holding 10,000 tons, stacking accommodation for 50,000 tons, and cranes, ½-in. to the foot. It is situated at the head of the bay, about 4 miles from the entrance to the harbour, and is said to be the second largest in the world. It is 1,140 ft. long by 188 ft. wide and 110 ft. on the floor, with a depth on the sill L.W.O.S.T. of 55 ft. It is built in two compartments, the outer being 600 ft. long and the inner 440, which can be filled and emptied independently or together, taking 47 minutes to fill and four hours to empty. It is being constructed by the engineers of the Railways and Harbours Administration, the caissons having been supplied by Messrs. Armstrong, Whitworth and Co., and the pumps by Messrs. Gwynnes. A third model on a scale of 16 ft. to the inch shows the beauties

&c., conveyors and transporters by which 1,000 tons can be loaded per hour into ships' bunkers. An oil fuel station built on 70 acres of reclaimed ground was opened last year by the Government. The British Imperial and Anglo-Persian companies have already erected fueling stations on it for crude oil and motor spirit, and the British Imperial Company has also established a factory for making cases and tins with an output of 3,000 cases and 6,000 tins a day. A new graving dock to be completed this autumn is shown in another model on a scale of

and conveniences of the beach and marine parade. Port Elizabeth in various ways shows the principal features of the town and district.

The immediate importance which those who have organised the Exhibition attach to the several products exhibited may be gauged presumably by the space they respectively occupy. A glance at the plan shows the great importance that has to be attached to agriculture and allied productions. Both directly and indirectly the increase of agricultural production is a matter of interest to the engineering trade. Agriculture cannot be carried on to advantage without mechanical appliances, and in many parts of South Africa the smallness of rainfall makes great irrigation works indispensable to vast tracts of fertile land if they are to be properly developed. The increase of white population, again, means the increase of the market for the manufactures that South Africa imports, on many of which engineers are employed. Some part of this demand, not only for agricultural purposes, may be filled by opening branch factories, and some by direct importation. The exhibition contains examples of each.

The exhibit of the dairy and poultry industry in the eastern part of the pavilion is an example of a demand supplied from this country, in the shape of the refrigerating plant and cold store, a view of which is shown in Fig. 4. The plant has been

supplied and installed by Messrs. H. J. West and Company, Limited, and consists of one of their 4-cylinder vertical CO_2 compressors, with safety head and forced lubrication, direct-coupled to an alternating current motor running at 720 r.p.m., and delivering into a double-pipe counter-current condenser, the brine being cooled by a counter-current evaporator of similar design. The cold stores are fitted on all sides with triple glass windows, and are divided into three separate chambers, with an air lock, the space cooled being about 3,000 cub. ft. No brine pipes or direct expansion pipes are used in the store, the cold brine from the evaporator being circulated by a direct-coupled electrically-driven centrifugal pump in the air lock, through brine drums situated above a false ceiling over the store, an electric fan in each chamber maintaining the circulation of the cooled air. The normal temperature in the store is about 25 deg. F., and in spite of the considerable radiation loss through the glass the temperature of the store does not rise more than 5 deg. F. at night. All moving parts, as well as the gland, are provided with forced lubrication by a pump in the crank case, and thus no special packing is required. The suction valve is in the piston head, and is operated by its own inertia and the motion of the piston without any spring. By a patent locking device the whole suction valve plate can be removed readily without removing the piston, and all valves are easily accessible without disturbing pipe joints. The cylinders and crank cases are forged from solid steel, and all working surfaces are precision-ground.

An exhibit illustrating a manufacture that is in course of being started in South Africa is that of Messrs. Delfos, Limited, of Pretoria, who, near the exhibit of building materials, show rock drills, which they have arranged to manufacture in Johannesburg in conjunction with the Atlas Diesel Company, Limited, of London. The exhibit itself (Fig. 5) includes a stope drill, a jack or bob hammer drill, and a number of spare parts for these and drills of other types. The most striking feature in these is the arrangement of the bob hammer drill (Figs. 6, 7 and 8), by which the mechanism for rotating the drill automatically, which characterises such hammers, is arranged to operate a valve, closing the air exhaust valve and admitting live air from time to time down the centre of the hollow drill, so as to clear it of dust and cuttings. Other local manufactures are a graphic air recorder for measuring compressed air, designed and calibrated by the Rand Mines Compressed Air Department, exhibited by Messrs. E. W. Tarry and Company, Limited, of Johannesburg, and a 4-in. patent Robeson-Davidson slime pump, which is exhibited by Messrs. Wright, Boag and Company, Limited, of Johannesburg. These pumps, which are made from 3 in. to 14 in., were invented and designed on the Witwatersrand Gold Fields to deal with fines or well crushed material from ¼ in. to slimes. The wearing surfaces are lined with white iron, and the stuffing boxes are protected by a clean water service under pressure. The inside covers of the pumps are drilled to enable the casing to be reversed when it is desired to convert the pumps from right-hand drive into left-hand drive. A few other exhibits show a small amount of miscellaneous manufactures. These, however, do less than justice to the extent to which metal and engineering manufactures have progressed in the Union. In the last available returns such manufactures stood at some 20,000,000*l.*, of which about 9,000,000*l.* was value added to the raw materials by manufacture, about the same as the value added by manufacture to food and drink products. Allied industries are those of building materials—bricks and tiles, cement, cement boards, Hume reinforced concrete pipes made on a centrifugal process, asbestos-cement, and other asbestos products, fire bricks, and crucibles.

Of the agricultural and pastoral industries the most important for export purposes is that of wool and mohair. The exhibits of these products are said to represent not the best that the Union produces, but a fair average of what is actually shipped, and in texture, length of fibre and general quality to hold their own with the products of any part of the world. Of these, as of other pastoral and of agricultural products, both raw and manufactured, a very large variety is shown, the more usefully to those interested in them by reason of the detailed catalogue; as much may be said of ostrich feathers, hides and skins, cotton, chemicals, and many other products and industries.

(To be continued.)

SOUTH AFRICA AT THE BRITISH EMPIRE EXHIBITION.

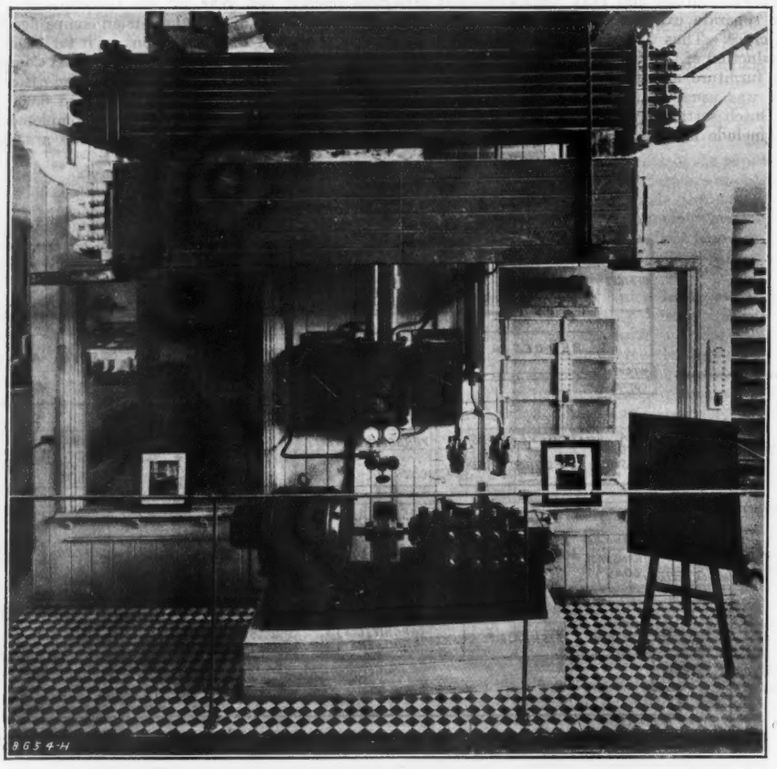


Fig. 4. Refrigerating Plant and Cold Store.

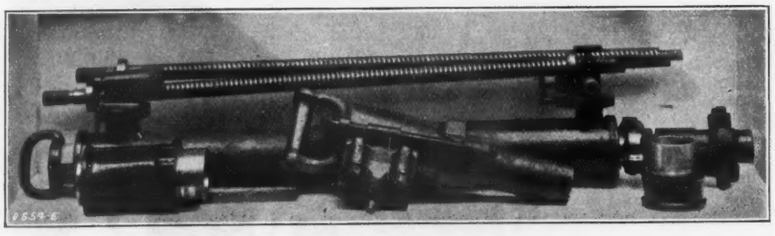
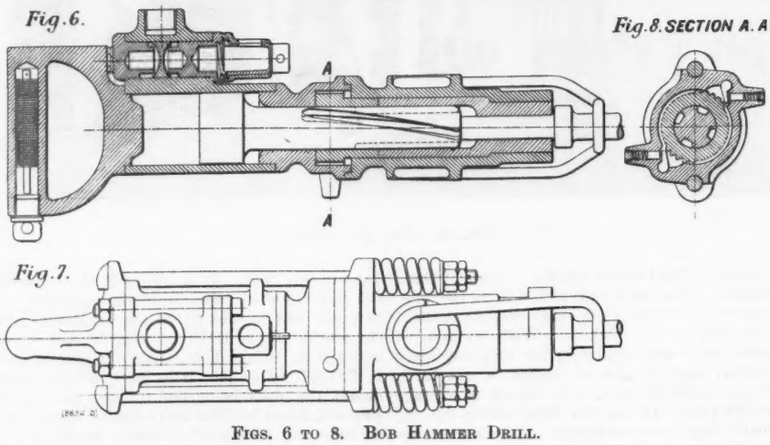


Fig. 5. The Delfos Rock Drill.



Figs. 6 to 8. Bob Hammer Drill.

THE EXPLOITATION OF AN ULSTER COALFIELD.

ALTHOUGH all the coal used in the shipbuilding, engineering and other industries of Belfast is imported from Great Britain, there appear to be available coal resources in Ireland, which have received very little consideration in the past. Sir Samuel Kelly has, however, decided to undertake the development of an area of considerable promise in the district known as Coal Island near Lough Neagh. This area is in the heart of Ulster but is only 50 miles by rail or canal from Belfast. Here, in the boring operations conducted by experts from English and Scottish mines, a good bituminous coal seam was struck at a depth of 433 ft. It was then decided to sink two shafts of 12 ft. diameter to a depth of 1,070 ft. and 62 ft. apart. The first shaft was begun in the autumn of 1921 and was completed last spring, while the second, which was begun 18 months ago, has now also been completely sunk. Boring was entirely done by compressed air rock drills, and as each 25 ft. of excavation was completed a temporary lining of timber and iron rings was erected, which was replaced later by specially prepared blocks which now line the shafts from top to bottom. The junctions have been secured by brick side walls and steel girders, and the roadways have been made with circular steel girders and reinforced concrete. Water difficulties have not been encountered to any great extent, and a triple-ram pump at the No. 3 level which raises the whole of the water to the surface could deal with much greater quantities than those encountered.

As an indication of the richness of the Coal Island field it may be stated that within the depth of the shafts there are no fewer than twelve seams. The thickness of each of these is given in the table.

No.	Depth in feet.	Name.	Thickness.
			ft. in.
1	433	Kelly	4 9
2	476	Crow	4 6
3	542	Annagher	9 6
4	570	Bone	6 3
5	625	Shining	2 6
6	691	Brackaville	4 6
7	761	Beltiboy	2 0
8	775	Monkey	0 9
9	806	Two Foot	2 6
10	898	Rock Coal	0 9
11	950	Ten Inch	1 0
12	986	Derry Five Foot	2 3

On the evidence afforded in the boring and shaft-sinking operations, Sir Samuel Kelly decided to obtain further extensions of the area of the coal rights he originally controlled up to an area of four square miles.

The erection of the necessary equipment at the pit-head was proceeded with simultaneously with the shaftsinking. Two engine houses were built, as well as a power station between them. Overhead equipment, screening and washing plant and an extensive series of mechanics', smiths', joiners and other stores and shops have also been built. Sidings amounting to over 5,000 ft. were made and connected to the Great Northern Railway. There are eight sidings in all, four under the screening plant, one for loaded wagons and three for empties. Steam is generated in three Scotch marine boilers for a total power production of 2,500 h.p. In the generating station there are two sets, the one for the supply of electric power to work the pumps and the other for lighting. A Belliss and Morcom engine drives a three-phase alternator for power purposes. The air supply for the rock drills is obtained from an Allen and MacLellan compressor. Each shaft is provided with a couple of double-decked cages, each capable of carrying 10½ cwts. of coal. These are controlled by a pair of horizontal engines of 250 h.p. provided with 12-ft. diameter winding drums. The cages are suspended by cables tested to carry 50 tons, although normal working will only load them to one-tenth of that amount. Six steel wire guiding ropes for the cages are attached above to the headgear and weighted at the bottom with cast-iron cheeses of 4½ tons. The screening plant is operated by a 50-h.p. three-phase motor. All the steel work of the head gear, the gantry screens, the picking plant and the washery were supplied and erected by the Blantyre Engineering Company, Limited, of Glasgow.

In the opening up of this coalfield Sir Samuel Kelly had the assistance of Mr. Thomas S. Durham, of Whitehaven, as consulting engineer. A yield of at least 100,000 tons of coal per annum is anticipated for a period of 40 years from the newly-constructed mines, but there is much coal also available in the surrounding basin. There are at present 200 workers from Scotland at work in the pit, but this is to be augmented to 1,200 in the course of a few months. It may be noted in passing that Sir Samuel Kelly has also started earthenware, pipe and china clay works in the district, as well as brick works and a spinning mill. The town of Newtownkelly, providing houses for the workpeople, who are finding employment in these schemes, is growing up rapidly, and already over 100 model houses have been built, while many are in course of erection.

INTERNATIONAL COMMISSION ON ILLUMINATION.

UNDER the presidency of Dr. E. P. Hyde, of the United States of America, the Sixth Session of the Commission Internationale de l'Eclairage was held at the Palais Eynard, Rue de la Croix Rouge, Geneva, from Tuesday, July 22, to Friday, July 25. Meeting facilities were kindly granted by the University of Geneva. In the opening proceedings, Mr. Filiol, President of the National Swiss Committee, said, incidentally, that electric lighting in Geneva dated from 1887, and that the power station which served the canton provided for about half a million lamps, or 3·5 lamps per head of the population affected. He therefore thought that they had reached the limit of lighting, unless new methods could be discovered which would contribute to a wider diffusion and further progress.

The President announced that Belgium was about to form a National Committee on Illumination, and that a National Committee of the Union of South Africa had been recently constituted.

The accounts of the previous three years, presented by the Hon. Secretary and Treasurer, Mr. C. C. Paterson, showed such a favourable state of affairs that it was proposed that the subscription from each represented country be substantially reduced. This was readily agreed to.

The first subject considered was the adoption of a primary standard of light. A paper was presented by Mr. H. E. Ives (U.S.A.) and reports submitted by committees of France and the United States. In connection with the latter Dr. Sharp submitted the following:—(1) "That the International Commission on Illumination recommends the international adoption as the primary standard of light of the brightness of a black body operated under conditions which are subject to accurate specification. (2) That the Commission recommends the national laboratories to take steps to formulate standard specifications for the construction and operation of the black body as a primary standard of light; and (3) To fix upon a definitive figure for the brightness of such body expressed in international candles per square centimetre."

In the discussion which followed Mr. Walsh supported the idea of referring the question to the national laboratories. Mr. Vautier thought it was advisable to make it clear that in this work it was not intended to exclude the laboratories of private bodies.

Mr. Fabry then summarised the report on "Standards of Light Suitable for Photographic Sensitometers," written for the Commission by Mr. Jules Baillard. Dr. Crittenden said he was afraid that the hope expressed by Mr. Baillard of securing a definite specification for acetylene lamps might be disappointed. If one were to attempt to make precise specifications he thought it would be simpler to use electric lamps. Mr. Paterson agreed that as a provisional measure, if a primary standard were to be established, an electric lamp might be adopted to begin with, but, he thought, the black body would have to be resorted to eventually.

On Tuesday afternoon, Mr. Fleury presented the French National Committee's "Rapport sur les travaux concernant le Vocabulaire de l'Eclairage." He was followed by Sig. Bohm, who presented that of the Italian Committee.

In discussing this subject Dr. Mailloux pointed out that in the preparation of vocabularies there were two systems available, either the alphabetical, or the logical and co-ordinated. The latter had the great advantage of placing in perspective before the eyes of the observer all terms relating to the same or cognate subjects. He recommended that each National Committee should send to the central body suggestions with regard to the different subjects under different headings; and that after the material had been assembled and co-ordinated the whole matter should be referred to the International Commission for consideration. He suggested that the work should be commenced at once. Mr. Bossu and Mr. Blondin agreed; the latter thought it might be desirable to appoint an International Committee on the subject. Mr. Dunn suggested that matter should be referred to the existing International Electro-Technical Commission, but Dr. Mailloux, as its President, thought it would not be practicable for it to take over additional heavy work. He considered the best arrangement would be for the subject to be handled by a small committee of three, one of whom should be Swiss, and should act as permanent chairman. The Electro-Technical Commission would do all in its power to assist. Mr. Fabry considered it would be desirable to add an Italian member, and Mr. Paterson suggested the appointment of correspondents for each country.

Dr. Mailloux later expressed the view that if the matter were placed in the hands, as had been suggested, of the Swiss Committee only, their report would not be regarded as carrying as much weight as one from an international body; but Mr. Dunn remarked that, if a Swiss Committee undertook the work, their findings would have to be submitted to the International Commission for approval and adoption. They would thereby be given the status of findings of the International Commission itself. Mr. Paterson supported the idea of the Swiss National Committee taking over the work. Mr. Joye said what the Swiss Committee had so far really done was to translate into French and German the Italian vocabulary. It had not dealt with the material in a logical order, but merely alphabetically.

The President stated that at present only four languages for the proposed vocabulary were contemplated, viz.: French, English, Italian and German. The motion for the appointment of a small committee was then unanimously agreed to.

Wednesday morning's proceedings (with Professor Fabry, President of the International Committee of Heterochromatic Photometry, in the chair) opened with a paper on "Heterochromatic Photometry: Progress of Work carried out at the National Physical Laboratory," by Messrs. Brookes, Buckley and Collier.

Mr. Jouast (France) then briefly introduced his paper, "Sur l'emploi des écrans absorbants en Photométrie Heterochrome"; and a paper on "The Relative Visibility Function" followed, by Mr. K. S. Gibson (U.S.A.). Mr. Walsh, in opening the discussion, said he had received from Dr. Rayner, of the British National Physical Laboratory, a message containing the suggestion that if the work of the Heterochromatic Photometry Committee were to be continued it would be valuable if the present Commission would set up another committee to deal with the transmission curves of colour filters in heterochromatic photography, which had a bearing also on other subjects.

Mr. Paterson read the following resolution which he had drafted:—"That the Commission adopt at this session a provisional table of values for the visibility function, and request the Editing Committee to draw up a suitable resolution under the guidance of Professor Fabry, Dr. Hyde and Mr. Buckley, with power to co-opt." Dr. Hyde supported this.

Mr. Crittenden, Mr. Jouast and Mr. Joye having spoken in support of the resolution, it was put to the meeting and carried. Mr. Joye remarked that physicists were not very far advanced in the subject of colorimetry, and thought that it would be better at that stage to institute a special committee, and that the Committee on Heterochromatic Photometry should extend its field of action.

Mr. Jouast said that it was of importance to compare the standards with regard to the different colours, and thought it might be useful to compare the results arrived at with given wave-lengths. According to French legislation, standards were calculated on the basis of carbon incandescent lamps, but manufacturers were allowed to use a tungsten lamp. Mr. Fleury thought it would be best to choose as a primary colour that of the carbon filament lamp or the tungsten filament lamp and to make a choice at once.

Dr. Hyde observed that the difficulty referred to by Mr. Jouast had existed for many years. For his own part, he would emphasise the adoption of some standardised method of flicker photometry. Mr. Fleury remarked that the colour temperature of the lamp would have to be agreed upon; and Dr. Hyde observed that when vacuum tungsten lamps were to be measured the measurements started with the use of vacuum tungsten standards of the Bureau of Standards (U.S.A.) as a basis. With gas-filled lamps, gas-filled standards were necessary, and those had been derived by comparison with the gas-filled standards of the Bureau, who had bridged the colour difference once and for all. It seemed to him that it was quite satisfactory to accept the Bureau's results until a better value became known.

A vote was later taken on the question of the appointment of a committee of three persons to study all matters relating to Colorimetry, this proposal being adopted.

NARROW-TYPE CONCENTRIC PISTON RINGS FOR AUTOMOBILES.—The Specification No. 5023–1924, issued by the British Engineering Standards Association contains a schedule of standard dimensions for narrow-type piston rings of the concentric type for cylinder-bore diameters ranging from 2-in. to 6-in. in ¼-in. steps and from 50 mm. to 150 mm. in 5-mm. steps, together with a series of explanatory clauses covering nomenclature, formulæ for cylinder-wall pressure, form of joint, free gap, gap clearance for closed rings and intermediate and oversize rings. Copies are obtainable from the Association's Offices, 28, Victoria-street, S.W.1, at the price of 1*s.* net or 1*s.* 2*d.* post free.

INDUSTRIAL NOTES.

Those who studied the census of production (1907) must have been struck with the large ratio which the costs of distribution often bear to the costs of winning or costs of manufacture. It further appeared from the figures then published that railway rates were responsible for but a small proportion of the difference between pithead and factory costs, and the prices paid by the ultimate consumer. This question of distribution costs has been carefully studied in America along scientific lines, and, as in this country, it was shown that for equal service the distribution costs of co-operative societies were at least as high as when the work of distribution was carried out by ordinary retailers. As is well known, there have recently been complaints as to the large difference between the cost of coal at the pithead and as delivered to the consumer's cellar, and it cannot be said that the original reply of the coal merchants to Mr. Shinwell's queries was calculated to inspire public confidence. Recognising this, perhaps a little belately, the Coal Distributors' information department have now published some further particulars as to the actual costs and profits of six representative London coal merchants, as certified by a firm of chartered accountants. According to this certificate the average figures for the last two years were as follows :—

	1921–22.		1922–23.	
	s.	*d.*	*s.*	*d.*
Average price obtained	54	6	42	6½
Average cost delivered at depot, *plus distribution expenses*	53	8¼	41	9½
Average profit per ton	0	9¾	0	9

The distribution costs in the two years in question are stated to have been the following :—

	1921–22.		1922–23.	
	s.	*d.*	*s.*	*d.*
Wages of loaders per ton loaded (including picking out slates, screening, tareing sacks, foreman's fee, landing coal to heaps, &c.)	2	2	1	11
Wages of carmen and motormen per ton carted (including driving money, attending at stables, long journeys)	2	11½	2	6¾
Cartage expenses per ton carted	3	0¾	2	5
Sacks per ton carted	0	5½	0	3¾
Siding rent, weighbridge charges, wharf rent, demurrage, &c.	0	3½	0	3
Clerical salaries (including managers)	2	2½	1	11¾
Establishment charges	1	3½	1	3½
	12	5	10	8½

No allowance is made in the above table for loss on small coal and deficiencies, which loss was estimated by the Advisory Committee to the Mines Department in 1922 to amount to 9*d.* per ton.

The Hull Corporation Tramways Committee accepted, on Monday last, the tender of Messrs. Bolckow, Vaughan and Co., Limited, Middlesbrough, for 1,500 tons of rails at a cost of 17,936*l.* A German tender was 3,000*l.* less, and a Belgian tender 2,700*l.* cheaper The committee felt, however, that the work should be kept in this country.

In the "Historical Review of Coal Mining" recently issued by the Mining Association of Great Britain to supplement their interesting exhibit in the Colliery Museum at Wembley, no article will be read with more interest than that in which Mr. Frank Hodges deals with "The Miner and his Trade Union." Mr. Hodges is described as First Civil Lord of the Admiralty, but he is better known in his relation to the Miners' Federation, and his article traces very candidly both the evolution of that body and the aspirations he attributes to its members. Whether they are in fact held by the general body of miners, or are enforced on them by an active and dominant minority, they are sufficiently well known; but what perhaps is not recognised so generally is the extent of the mechanism by which it is hoped to realise them. "Not content," as Mr. Hodges says, "with exerting an influence on the councils and conferences between themselves and the employers within the industry, they have stretched out into the sphere of politics and provided machinery for the influencing of Parliamentary opinion, which no other organisation has ever done. At the present moment there are 43 members in the House of Commons who are run exclusively under the political representation scheme financed by the miners themselves. Their expenses are paid by the miners' organisation. They are in the House of Commons to influence legislation in favour of the miners. . . . They form nearly one-fourth of the British Labour Party." Elsewhere in the article it is pointed out that for attaining the objects in view miners are depending largely on a development of the political outlook of the workers of the country as a whole. The treatment of grave economic questions by political methods may be open to grave objections, not least when the questions affect the entire community and the political influence is applied on behalf of a single class. Such influence may enable a class that is powerfully represented in the House to procure legislation in its own favour at the expense of other classes or even of the entire community, in return not for value given to the community or the classes interested, but for support given to the purposes of a political party. The present miners' group may not contemplate any such action, but the Parliamentary weight they have acquired, and the purposes for which they avowedly wish to use it, cannot be viewed with indifference by the community as a whole.

In the 42nd annual report of the Ship Constructors' and Shipwrights' Association, Newcastle, Mr. Alex. Wilkie, the general secretary, states that unemployment in the shipbuilding industry was abnormally high throughout last year. With respect to new and repair work going to the Continent, the report pointed out that this was a matter which affected not only the employers and the workmen concerned but the country as a whole. There should be an impartial inquiry into the facts and assertions made, both with regard to wages and conditions abroad, and likewise the methods adopted both in this and other countries. If the industry was to regain its position there would require to be a more equitable distribution of the fruits, and not merely the policy of attacking wages every time. Experience had shown that low wages had not brought about that improvement hoped for, as by decreasing the purchasing power of the people it had simply accentuated the position, and therefore other means and methods must be adopted to preserve the industry which would enable it to pay adequate remuneration to those engaged in it.

Some interesting, but highly disturbing figures, as regards our export trade, were submitted at the last week's conference of engineering employers and the engineering Trade Unions. It was stated that according to the census of production for 1907, home orders then formed 46·65 per cent. of our total trade. In 1922–23 the percentage in the engineering and allied trades was 72·52 per cent., and so far the figures for 1924 show the home trade to be responsible for 74·11 per cent. of the total orders. At the same time our imports of manufactured metals are steadily, if slowly, increasing. Pig-iron, it was stated, was being sold at nearly 1*l.* below cost of manufacture, and steel at nearly 2*l.* per ton below the cost of making. On some electrical contracts British tenders were 725,768*l.*, but most of the work was secured by Swiss and Scandinavian firms whose tenders for the work amounted to 563,731*l.* In another case for general engineering work abroad, British tenders amounted to 423,445*l.*, whilst the work was secured by French and German firms, who undertook to do the work for 283,520*l.* It was further pointed out that suggestions had been made that in order to facilitate the payment of reparations, Germany should be permitted to standardise a working week of more than the 48 hours provided for by the Washington Convention.

In respect to this question of the eight-hour day, attention might perhaps be called to the observation made during the week by Mr. Shaw, the Minister of Labour, who is responsible for the eight-hours bill, of which the text was published on Monday. This bill provides generally that all labour in excess of eight hours must be paid for as overtime. He says that if the employer wants special privileges and asks for overtime he must pay extra for that overtime. This remark would seem to indicate that Mr. Shaw believes that the additional charges he proposes will affect the employer only, and that he does not realise that they must ultimately be borne by the consumer. It is in general, the community, not the employer, which is hit hardest by high prices, since the employer will not remain in business, or at any rate, will cease to extend and develop his works unless the community will consent to buy his goods at prices permitting a reasonable return for the capital and energy expended.

The last building trades conference broke up with some display of temper, and consequently it has been decided to wait a few days before arranging for another meeting. One of the points at issue is the demand that payment shall be made for time lost through bad weather. It is stated, however, that experience during the war years, in which this claim was to some extent conceded, shows that when the outdoor men were driven in by wet, the indoor men who were wholly unaffected, ceased work too, as they did not see why the outdoor men had any more right to be paid for doing nothing than the indoor men had. The unions declare the object of the employers is to try and establish some system of remuneration on the basis of work done, rather than on that of time expended. They declare this will lead to scamped work and jerry building. This declaration will, probably, not be taken too seriously by those who are acquainted with the facts. The building regulations and the building inspectors should be a sufficient safeguard against jerry building, whilst as regards scamped work it is notorious that no safeguard against this is secured by fixing payments on a time basis. This was very clearly shown some years since in connection with some experiments of the Royal Institute of British Architects on the strength of brick piers. The work being undertaken for scientific purposes, the men were paid by time and given to understand that they were to do their best to make a good job. It turned out, however, when the piers were subjected to test that various kinds of scamping tricks had been practised, and a whole fresh series of piers had to be provided. In fact, the only safeguard against scamping is efficient inspection, and it is quite as easy to provide for this when men are working on piece as when they are working on time.

The present shortage of labour in the building trades lends special interest to the suggestions made by Lord Weir in the House of Lords last Tuesday. He suggested that the Government should arrange for standardising three classes of house. He said that the only known principle under which effective production could be secured without skilled labour was by standardisation. The most suitable materials for the main structure of houses would be a combination of timber and steel plate. The use of these materials would eliminate the bricklayer, while a multiple production of timber units, with the use of jigs and other methods would make them independent of the skilled joiner. The inner walls and partitions would be lined with wood or composition board, and no plasterers would be required. The use of either metallic shingles or asbestos sheets for roofs would not involve the employment of slaters. By standardising the layout, all the pipes and electric wiring could be produced by factory methods, independent of the plumber and electrician. By the standardisation of equipment and fittings the problem of baths, sanitary conveniences, &c., was rendered much simpler. Thus, the middleman would be eliminated and costs reduced. These principles of production had been applied with complete success in war time. But there was this difference—during the war no good men were unemployed; to-day over a million were out of work, many of whom would be available for his scheme. He had no hesitation in saying that if his scheme were applied on a sufficiently large scale, a three-room house with scullery and bathroom, but exclusive of land, roads, and drains could be made and erected at a cost of under 300*l.*

A committee has been appointed by the Board of Trade "to inquire into and report upon the conditions and prospects of British industry and commerce, with special reference to the export trade, and to make recommendations in regard thereto." A memorandum accompanying the terms of reference states that the first question to be settled is the present position and future prospects of British overseas trade. In the second place attention should be directed to our productive capacity, and in particular to the possibilities and limitations of large-scale production, whilst thirdly, methods of remunerating workmen and of avoiding trade disputes should be examined.

University of London—University College.—A list has been issued by the Provost of the College of the recent awards, scholarships, prizes and diplomas in the Faculty of Engineering.

Iron and Steel Castings for Automobiles.—The following specifications for iron and steel castings for automobiles have just been published by the British Engineering Standards Association, 28, Victoria-street, S.W.1, at the price of 1*s.* net; post free 1*s.* 2*d.*:—No. 5024–1924. Iron Castings for Air-Cooled and Jacketed Cylinders; No. 5025–1924. Iron Castings for Sand-cast Pistons and Valve Guides; No. 5026–1924. Iron Castings for Flywheels; No. 5028–1924. Steel Castings. The specifications include clauses relating to chemical composition, heat treatment, mechanical tests, and the provision of test samples. The chemical compositions called for in the specifications for iron castings are considered to be of less importance than the mechanical tests required. The limits of the compositions, accordingly, have been set as wide as possible, and represent the extreme proportions of the different constituents which may be present in a good and serviceable material. Proportions of the constituents outside the specified limits are considered to be inconsistent with the best quality of material. It is desirable, therefore, in the use of these specifications, that the mechanical properties should be regarded as the main requirements, and the chemical composition as an auxiliary check upon the suitability of the material to perform the duties required from it.

WATER-TUBE BOILERS AT LONDONDERRY POWER STATION.

CONSTRUCTED BY MESSRS. YARROW AND CO. (1922), LIMITED, ENGINEERS, GLASGOW.

Fig. 1. SECTIONAL ELEVATION ON LINE A.A.

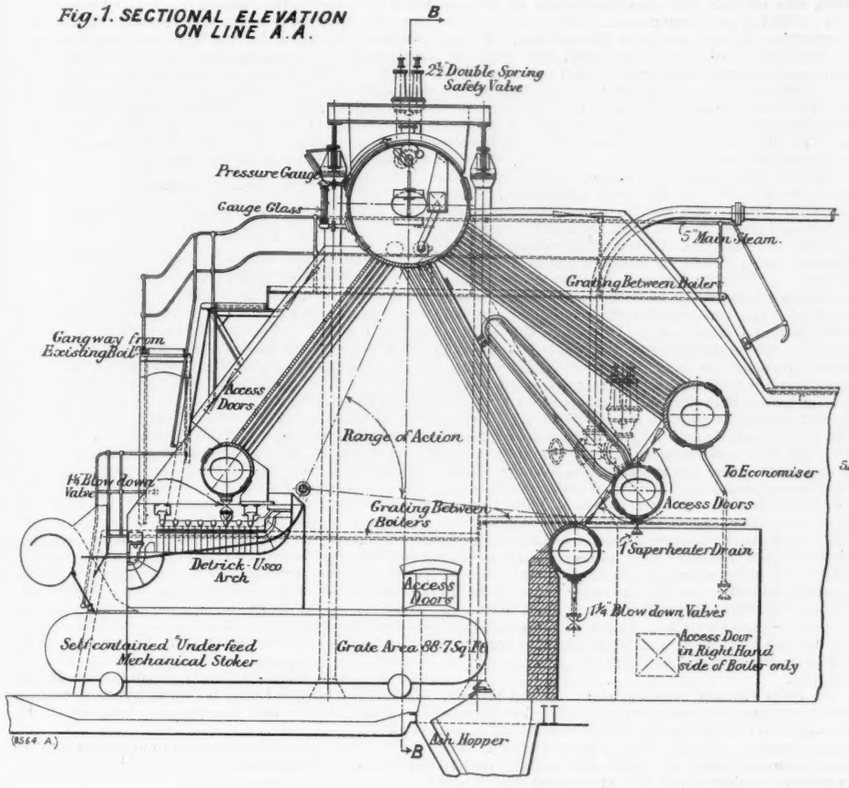


Fig. 2. SECTION ON LINE B.B.

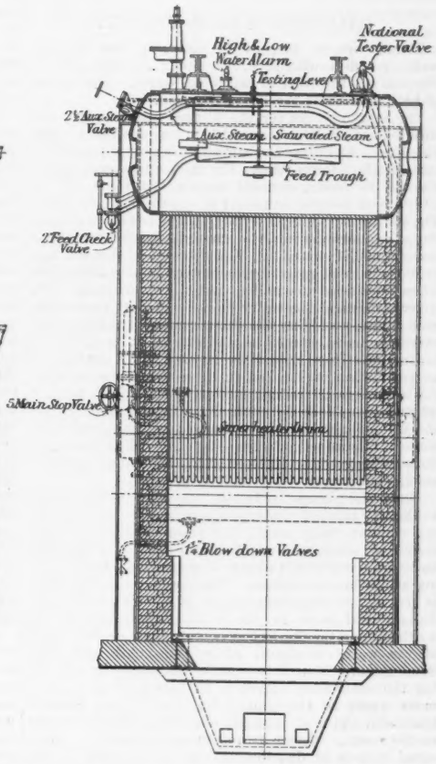
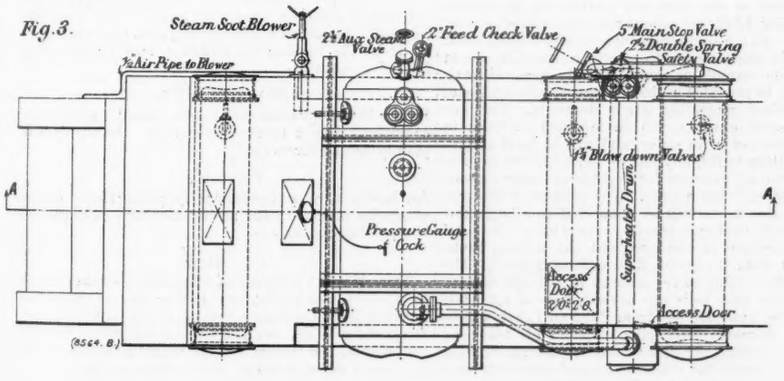


Fig. 3.



YARROW BOILERS AT LONDONDERRY POWER STATION.

IT is somewhat surprising that the Yarrow boiler which has for many years held an honourable position in Naval practice, has only recently been adopted in Electric Power Stations where the requirements of quick steaming and economy of space are analogous to those which obtain in warships. The merits of the design are, however, now becoming more generally appreciated on land, and as is generally known, a number of these boilers have been installed in the large Power Station at Barking, which is on the point of completion. Other power stations on which Yarrow boilers have been adopted are those at Dunston-on-Tyne and at Brighton. The two characteristics of the Yarrow boiler which appeal particularly to engineers are the large combustion space and the straight tubes. The latter feature is perhaps of less real importance than it was once considered, but more and more attention is being given to the design of combustion spaces, the tendency being in the direction of continually greater volume than has been thought to be adequate in the past. On the recommendation of the City Electrical Engineer, Mr. R. V. Macrory, M.I.E.E., the Londonderry Corporation was one of the first to order such boilers for a power station—two of them—for their Power House extension, to be constructed by Messrs. Yarrow.

The installation of these boilers has now been completed, and they have passed their official test under the supervision of Mr. Macrory with the results which we give below. One of the Londonderry boilers is illustrated in Figs. 1 to 3, above. It has a heating surface of 3,255 sq. ft., additional to which is a superheating surface of 410 sq. ft. and an economiser surface of 1,550 sq. ft. The total grate area is 88·7 sq. ft. The boiler, as will be seen from the illustrations, has one steam drum and three water drums connected to it by straight tubes, and there is a superheater consisting of one drum into which U-tubes are expanded. The arrangement is such that all the superheating surface is at the back of the boiler in the passage of the gases to the flue. The narrow front bank of tubes acts as a screen, but being exposed to direct radiation from the furnace, the tubes provide most valuable heating surface. After passing the back nest of generating tubes and the superheater, the gases go through a damper to a separate economiser of Green's vertical cast-iron type with standard scraper gear. The stokers with which the boilers are equipped are of the Underfeed self-contained type.

TABLE I.—*Trials of Yarrow Boiler at Londonderry Power Station.*

Particulars of Boiler.	1st Trial	2nd Trial.	3rd Trial.
Heating surface, generating ..	3,255	—	—
" " superheating ..	410	—	—
" " economiser	1,550	—	—
" " Total	5,215	—	—
Grate area, 88·7 sq. ft.			
Balanced draft			
Fuel—	About	About	About
Calorific value of fuel as received	11,000	11,000	11,000
Coal consumed per hour, lbs. ..	1,638	2,390	2,886
Coal consumed per square foot of grate per hour	18	27	32·5
Temperature at chimney base ..	295	354	397
Boiler room	76	81	77
Temperature of feed water entering economiser	108	91	87
Temperature of feed water entering boiler	202	219	213
Steam pressure	194	201	220
Steam temperature leaving superheater	543	586	622
Total water evaporated per hour from and at 212 deg.	15,633	22,179	26,821
Water evaporated per square foot of heating surface per hour from and at 212 deg.	4·9	6·9	8·2
Efficiency	89·4	87	86·2

Table I above gives a record of the results obtained on the official trials. Unfortunately, the conditions at Londonderry were such that it was only between 2.0 p.m. and 5.0 p.m. that the load was sufficient to require all the steam from one Yarrow boiler. Hence it was decided that two-hour tests should be taken, the boiler having been steaming at the same rate for one hour previously. The test-periods being so much shorter than is desirable for boiler trials, confirmatory tests were made on successive days, under official observation, and we are informed that the Station Engineer was satisfied as to the accuracy of the trials. The makers state that they would not hesitate for a moment to guarantee the same results on a 12-hours' trial. The class of coal used, was washed pearls, from

the Afton Mine, Ayr, and it had the following analysis: moisture, 11·5 per cent.; volatile matter, 30 per cent.; fixed carbon, 46 per cent.; ash, 12·5 per cent. The CO_2 recorded on the trials was never less than 15 per cent. and the mean value of the readings was 15·2 per cent. The figure of 15 per cent. has been taken in the official tests. There was an entire absence of CO.

CALCUTTA WATER SUPPLY.

There are at present in Calcutta two distinct water supplies with separate piping systems, one of filtered, and the other of unfiltered, water. The source of both systems is the River Hooghly.

The intake works for the filtered water supply are situated at Pulta, about 17 miles upstream from Calcutta. At Pulta the river water is pumped into four large settling tanks, where the matter in suspension is allowed to settle, assisted during the rains by the addition of suitable amounts of chemical precipitants. The silt deposited in the settling tanks has to be cleared out at regular intervals, the amount removed each year being 1,500,000 cub. ft. The disposal of this silt is a problem in itself and will present even greater difficulties when extensions now under construction are completed. After settlement the water flows by gravity on to slow sand filters, and after filtration is pumped through two cast-iron mains, one 42 in. and one 48 in. in diameter, to Tallah. These mains can be used in an emergency as gravitation mains, and in these circumstances they can discharge 20 million gallons per 24 hours against 40 million gallons by pumping. On reaching Tallah the water flows into underground reservoirs, and from these it is pumped into the city. At Tallah there is a large elevated steel tank, 110 ft. high above ground level. Its capacity is 9 million gallons.

From the pumps at Tallah the water is distributed to the city through three main pipe lines. Two of these are comparatively small, the main distributor being the 60 in. steel main which is laid along Circular-road and turns westwards along Dharamtallah-street, ending at Wellington-square. The pressure in the main is greatest in the northern part of the City nearest to Tallah, and least in the south; consequently the northern part of the city gets more than its fair share of the water available, while the south gets less. Some attempt is made to equalise the supply by regulating the controlling valves in the north so as to send more water to the south; but this is not entirely successful and is strenuously objected to by the people in the north. Better arrangements to ensure a more equal system of distribution will be provided in the new scheme now under construction. The existing plant was designed to supply 40 millions of gallons of filtered water per day, or about 40 gallons per head per day. It was hoped that with this quantity of water it would be possible to maintain a continuous pressure supply throughout the 24 hours; but as soon as the scheme was put in operation, it was realised that this could not be. The main reason could be traced to lack of civic education of the masses. Waste of water is considerable, and when the ordinary citizen learns to turn off a water tap as automatically as he turns it on, the solution of the problem will be much nearer than at present.

When the first installation of filtered water supply was introduced, it was very soon found that it was inadequate to meet the demands. It was then decided to introduce a supply of unfiltered water to be used for such purposes as sewer flushing, street watering and fire extinguishing. There are two unfiltered water pumping stations, one called Mullick-ghat Pumping Station, situated just south of the approach to the Howrah Bridge on the Calcutta side; the other is known as Watgunge Pumping Station and is situated just south of the Hastings Bridge, over Tolly's Nullah. Both these stations pump the river water direct into the distribution mains without treatment of any sort. Until recently both pumping stations were equipped with steam-driven pumping plant. The old plant, which was removed from Watgunge a year ago to make room for the new electrically-driven pumps, had worked for 20 years at Mullick-ghat, and after being removed from Mullick-ghat and installed at Watgunge, had worked for a further period of about 26 years. The new plant and the old plant now working at Mullick-ghat had served their time and had amply repaid their cost. These old pumps supplied about 20 million gallons per day.

When the Corporation decided, in 1920, to undertake a fresh scheme for the improvement of the water supply, they had to come to a decision on two important points before proceeding with designs and estimates:—(*a*) it had to be decided whether the unfiltered water supply system with all its disadvantages and menace to health, should be retained or abolished and replaced with a filtered water supply only; also (*b*) what quantity of water should be provided, and for what future period of years the scheme should be designed to serve.

With regard to the unfiltered water supply, the Corporation resolved to abandon the use of this and supply filtered water only. They also decided that the total supply of filtered water should be 110 million gallons per day, which was considered sufficient to give the City an ample supply up till the year 1945, and on this basis the preparation of designs and estimates was commenced. Unfortunately, the Corporation did not adhere to this decision. Mainly on the ground of alleged economy, they rescinded their previous resolutions and decided not to abolish the unfiltered water supply, but to retain and extend it. The total amount of water to be provided was maintained at 110 million gallons per day, but divided into 70 million gallons of filtered, and 40 million gallons of unfiltered, water.

On this basis designs and estimates were prepared, contracts were let and the work commenced. Then came the proposal last year to extend the city boundaries, and it was decided that the adjoining municipalities of Cossipore, Chitpore, Manicktollah and Garden Reach should be brought within the jurisdiction of Calcutta. It was further resolved that arrangements should be made to provide these added areas with the same quantity of filtered and unfiltered water as that decided upon for Calcutta. This decision entailed the re-designing of the whole scheme and caused considerable delay. Fortunately, the original work had not proceeded too far; moreover, it was of such a nature that it could be extended to meet the altered conditions without much difficulty. None of the work already done had to be abandoned and, therefore, the only loss sustained was that of time consequent upon these alterations. Briefly, the works required to provide the additional quantities of water decided upon are: (1) more pumps at Pulta to raise the water from the River Hooghly to the settling tanks; (2) greatly increased area of settling tanks to deal with the increased river water; (3) more filter beds; (4) more pumping capacity at the pressure station to pump the filtered water from Pulta to Tallah reservoirs; (5) a larger pipe from Pulta to Tallah; (6) more pumps at Tallah to pump the water to the city; (7) more and larger pipes to carry the water to the city and to distribute it as equally as possible.

At Pulta the new pumping plant, instead of being scattered among several pumping stations located at a considerable distance apart, will all be collected at one central station situated close to the river bank. The new pumping plant at Pulta will include modern water-tube boilers, fitted with mechanical stokers and equipped with modern coal-handling and crushing plant. Each of the three new pumps will be capable of delivering 1,740,000 gallons per hour against a head of 120 ft. All the auxiliaries will be electrically operated and will be duplicated with reserve or stand-by steam units. The current for the electrically-operated auxiliaries will be provided in the pumping station by steam turbine-driven generating sets in duplicate. The four existing settling tanks will be modified to work in parallel, instead of in series, and will be used as pre-sedimentation tanks, any one of which will be capable of being put out of action for cleaning or repair without interfering with the supply. The outlets of the pre-sedimentation tanks will be connected to a large new settling tank, having an area of ¼ square mile. The total storage capacity of the new and old settling tanks combined will be about 250 million gallons. The existing filter beds have an area of 920,000 sq. ft., and the new filter beds will have an area of 1,232,000 sq. ft. The new pipe line from Pulta to Tallah will be a 60-in. diameter steel pipe, capable of delivering 54 million gallons per day under the normal working head. At Tallah the old underground reservoirs have a storage capacity of 8 million gallons, and the new underground reservoirs will have a capacity of 9½ million gallons. Adding the capacity of the overhead steel tank, the total storage capacity at Tallah will be 26½ million gallons. The new pumping machinery at Tallah will be similar to that at Pulta, and will consist of four centrifugal pumps, each pump being capable of delivering 1½ million gallons per hour against a head of 130 ft. The variation of delivery of water from Tallah to the city to meet the varying demand will be obtained mainly by starting up or closing down one or more pumping units.

The system of distribution will be greatly improved. The city will be divided into a number of well-defined zones, and each zone will have its own arterial main direct from Tallah pumping station to the centre of the zone, with branches to sub-zone centres. There will be no connection with the zone mains, and no water will be drawn from them between Tallah and the zone centres. This will ensure a much more equal distribution. With regard to the unfiltered water supply, Watgunge pumping station has already been electrified, half of the total equipment has been installed and set to work, and the supply to the northern portion of the city is better than it has ever been before. The plant at this station, when completed, will consist of six direct-coupled electrically-driven centrifugal pumps, the total pumping capacity being 30 million gallons per day against a head of 140 ft. At Mullick-ghat the work of installing the new electrically-driven pumps is in progress, one of the four old steam engines having been dismantled and removed. The first of the new units is installed and was set to work during the summer this year, an additional year being required to complete the installation. When completed there will be five large centrifugal pumps, each capable of pumping 15 million gallons per day against a head of 140 ft., and two smaller units of half this capacity. Each pump will be direct-coupled to a 6,000-volt A.C. motor. The total pumping capacity of this station will be 90 million gallons per day. Contracts have been let for the work, which, it is expected, will be completed within five years.

EXTRA HIGH-PRESSURE STEAM TURBINES.

V. Nordström (Chief Engineer, the De Laval's Angturbins Company, Stockholm).

The developments in steam engineering during recent years are, above all, characterised by efforts to obtain a better utilisation of the working power of steam by means of increased steam pressure. While 16 kg. per square centimetre was regarded as being about the upper limit some ten years ago, modern power plants are planned for pressures of 30 kg./cm.² and more, and steam pressures of from 50 to 100 kg./cm.² are within the range of practical possibilities.

Theoretically, the prospects of gaining a higher technical efficiency by this means are very good, since the adiabatic drop in heat obtainable by the higher pressure demands less expenditure of heat for the generation of the steam. Some doubt has been expressed, however, as to the possibility of utilising this extended range in heat, owing to the greatly increased losses in the turbine. The difficulties obviously become greater as the pressure of the steam is increased, inasmuch as the losses in the turbine discs due to friction and leakage are increasingly harder to control, the denser the driving medium is. Fortunately, there is a way of getting around this difficulty; in this case as in so many others relating to steam turbine design, the solution is to be found in fitting gearing between the high-pressure and low-pressure sections of the machine.

The work of a turbine required to overcome the disc friction may be approximately denoted by the formula

$$Nf = c\, d^2\, u^3 \gamma$$

in which d is the diameter of the disc and u its peripheral velocity, γ being the density of the medium causing the friction. By means of introducing n for the revolutions made by the turbine the equation may be given the following form:—

$$Nf = c_1 d^2\, (nd)^3\, \gamma$$

If Nf is to be kept constant at an increased γ while other conditions and u remain unchanged, the result will plainly be as follows:—

$$n = c_2 \sqrt{\gamma}$$

As, however, γ is approximately proportional to the admission pressure p the matter may also be expressed in the following way:—

$$n = c_3 \sqrt{p}.$$

Thus, if it is a question of designing a steam turbine for a pressure of 100 kg./cm.² having no greater friction losses in the discs than a turbine of the same capacity designed for 10 kg./cm.² and a speed of 3,000 revolutions per minute, the turbine for the higher pressure should be given a speed of $3{,}000\ \sqrt{10}$ or 9,500 r.p.m.

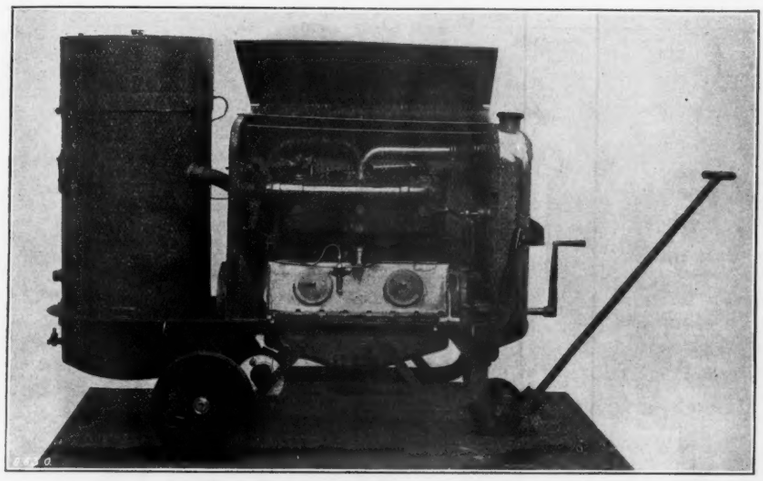
Owing to the greater adiabatic drop in heat obtained with the higher pressure, the number of discs or the peripheral speed must be increased, however, in order to obtain the same blade efficiency. From this it follows, that in order to keep the friction losses down, the rotary speed of the turbine must be still further increased, and, as there is no possibility of directly utilising the power produced at such a high speed, the solution suggested by Dr. Gustaf de Laval in the early 'nineties must be adopted. In designing his steam turbine plants for 100 and 200 kg./cm.² pressure he evolved toothed gearing for reducing the speed, and the same principle has since been successfully employed and further perfected by the A. B. de Laval's Angturbin in designing steam turbines for high pressures.

The conditions touched upon here naturally refer only to the high-pressure section of the turbine, the one in which the friction losses are of paramount importance. In selecting the speed at which the low-pressure turbine section is to run, efforts must be concentrated on obtaining as large outlet areas as possible in the last of the runners, in order to get the best effect out of the vacuum; *i.e.*, the rotary speed must be low, to keep the

* Paper, abridged, contributed to Section D of the World Power Conference on July 4, 1924.

PORTABLE AIR COMPRESSOR; EMPIRE EXHIBITION.

MESSRS. BROOM AND WADE, LIMITED, ENGINEERS, HIGH WYCOMBE.



blade velocity within reasonable limits. For turbo-generators of sizes from 500 kw. to 5,000 kw. the dimensions will as a rule be satisfactory if the low-pressure section is coupled direct to the generator, the speed of the high-pressure section being fixed independently in accordance with the principles stated above.

The introduction of toothed gearing between the high-pressure and low-pressure sections cannot be regarded as any real disadvantage, as its efficiency is extraordinarily high—98 per cent. and over—and the reliability is beyond dispute when the gears are correctly designed, the material properly selected, and the manufacturing methods perfect.

A. B. de Laval's Angturbin have built back-pressure, extraction, and condensing turbines on this principle for several years past, even for ordinary steam pressures, and have gained highly satisfactory results. To support this, may be cited a 600 h.p. turbine which consumed only 3·9 kg. steam per brake horse-power hour at 17 kg./cm.² pressure and 325 deg. C. steam temperature.

The very high steam pressures make it possible to use a much higher temperature than that which has been regarded as suitable heretofore. The steam turbine must in consequence be adapted to withstand this higher temperature, if the advantages of the high steam pressure are to be fully utilised. Thanks to the small size of the turbine when designed for such high speed, there are not insuperable obstacles in the way of achieving this end. Special care must be exercised, however, in selecting the material for parts exposed to the superheated steam in the high-pressure turbine, and it goes without saying, that no cast iron must under any circumstances be used.

The equipment of a turbine for high-pressure steam is on the whole, the same as for a standard turbine.

The very high steam pressures may in the first instance find employment in back-pressure turbines, where the economy of this arrangement is quite obvious. The gain in energy expressed in per cent. is really so considerable that the figures are apt to be quite astounding. The gain ought not to be estimated in this way, however, as this would be misleading, but should be based on the actual fuel saving. Looking at the matter in this light, it will be found that the gain under certain circumstances can be quite as large for a condensing plant, as for an extraction turbine, or for a combination of a back-pressure and a condensing turbine. The deciding point is, here, how high superheat can be employed at the higher steam pressure. It is indeed most probable that higher temperatures than those heretofore regarded as most suitable at standard steam pressure, may be used, because the greater heat capacity of the high-pressure steam will reduce the difference in temperature between the superheater coils and the steam. Only experience can show, however, how far superheating can be carried in excess of present practice.

In the following tables, the fuel saving has been given on the basis of different assumptions as regards steam temperature at higher steam pressures. The figure adopted for comparisons is 20 kg. pressure and 350 deg. C. steam temperature. It has been assumed in case of extraction turbines that the gain in power due to the higher pressure is exactly sufficient to make the condensing section superfluous. The gain for this type of turbine, therefore, is expressed in maximum figures. Proper consideration has been given to a certain loss of efficiency in the turbine as a result of the higher admission pressure; the greater work entailed on the feed pumps, on the other hand, has not been estimated, which, in most of the cited cases, makes the figures for the saving slightly too large.

TABLE I.—*Saving in Fuel Consumption at* 50 *and* 100 *kg./cm.² Steam Pressure, in Comparison with* 20 *kg./cm.² Steam pressure and* 350 *deg. C. Steam Temperature.*

(λ = 750 Cal.).

Exhaust Conditions.	96 per cent. vacuum.		1 kg./cm.² back press. (gauge).		3 kg./cm.² back press. (gauge).	
Admission pressure kg./cm.²	50	100	50	100	50	100
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
λ = 750 Cal. ..	8·5	11·5	10·0	13·0	9·5	13·0
350° C. steam temp.	7·5	9·0	9·0	11·0	9·0	11·5
400° C. " "	10·0	11·5	10·5	13·0	10·5	13·0
500° C. " "	15·0	16·5	15·0	16·5	14·5	16·5

TABLE II.—*Saving in Fuel Consumption for Power Purposes at* 50 *and* 100 *kg./cm.² Steam Pressure in Comparison with* 20 *kg./cm.² Steam Pressure and* 350 *deg. C. Steam Temperature.*

(λ = 750 Cal.).

Exhaust conditions.	96 per cent. vacuum.		1 kg./cm.² back press. (gauge).		3 kg./cm.² back press. (gauge).	
Admission pressure kg./cm.²	50	100	50	100	50	100
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
λ = 750 Cal. ..	8·5	11·5	42	48	47	53
350° C. steam temp.	7·5	9·0	40	45	46	51
400° C. " "	10·0	11·5	44	48	49	53
500° C. " "	15·0	16·5	51	53	55	57

If the saving is determined in per cent. of the fuel consumption for energy production, the result will be economy to the extent shown in Table II. It should, however, be borne in mind, that these figures refer to a smaller amount of fuel than the corresponding figures in Table I, and that the product of the said amounts and the percentage gain are in both cases equal.

THE "BROOMASTER" PORTABLE AIR COMPRESSOR.

AN air-compressing set of considerable novelty and interest, of which an example is being shown at the British Empire Exhibition, is illustrated in the figure above. The set is manufactured by Messrs. Broom and Wade, Limited, of High Wycombe, and, as will be seen from the figure, belongs to the portable class. Portability is indeed a special feature of the combination which has been designed throughout from that point of view. Many portable compressors are nothing more than the assemblage on a truck of a standard paraffin or petrol engine with a small air compressor, but in this case a special design of these elements has been developed to suit the particular conditions. The great departure from orthodox designs lies in the fact that the engine and compressor are combined in a single unit. This unit, as will be seen from the figure, has four cylinders. Of these two are engine cylinders and two are compressor cylinders. This arrangement results not only in a considerable reduction in weight, but also a considerable curtailment of the space occupied. The set has a swept capacity of 92 cub. ft. of free air per minute, which is sufficient for two pneumatic picks. It is mounted on a frame built up of riveted angles and carried on three unsprung wheels. An air receiver of 12 cub. ft. free air capacity is carried at the back of the frame. It can easily be dismounted if desired for transport purposes. The set is designed for a working pressure of 120 lb. per square inch and the receiver is tested to twice the working pressure. The overall height of the whole is 5 ft. 3 in. It is 7 ft. 6 in. long and 2 ft. 10 in. wide.

The four cylinders of the machine are of 92 mm. bore with 140 mm. stroke, and the speed is from 1,200 to 1,400 r.p.m. They are cast in one block, of close-grained cast iron and are water jacketted. The pistons are of aluminium alloy, each with three rings, while the connecting rods are H-section steel stampings, with split big end bearings made of bronze and lined with white metal. For the gudgeon pin end a solid bronze bush is fitted. The inlet and exhaust valves on the power cylinders are mechanically operated and are made from nickel-steel stampings. They are placed side by side, the stems being enclosed behind oil-tight doors, ensuring cleanliness and silence. The compressor valves are concentrically placed directly over the pistons, the inlet valves being of the mushroom type mechanically operated, and the delivery valves of the spring-loaded plate type. The camshaft is machined from steel bar and is hardened and ground. All the power cylinder valves and the compressor inlet valves are actuated from this shaft, which is driven from the crankshaft by enclosed skew-gear pinions running in oil. The governor is of the centrifugal type, actuating the throttle on the inlet. The mechanism is enclosed in an oil-tight case and can be adjusted while the engine is running. The governor can be relied on to prevent settled speed variation exceeding 3 per cent. to 4 per cent. from full load to no load.

Forced lubrication is used, a gear oil-pump driven from the crankshaft being fitted. Oil is drawn from the crankcase sump through a filter, and is forced through ducts cast in the crankcase which eliminate any need for oil pipes. The oil flows to the main crankshaft bearings, and thence to the connecting rod big-ends by way of the crankshaft, which is drilled. A water circulating pump of the centrifugal type is fitted, driven in tandem with the magneto. A large multitubular radiator is fitted for cooling the engine and compressor. It is provided with a fan driven from the engine. For running on petrol a single jet mechanical-type carburettor is fitted, and for running on paraffin there is an Aster patent vaporiser. Ignition is by means of high-tension magneto. A petrol tank with a capacity of 16 gallons is mounted on top of the air receiver, where it is very accessible. The air receiver is fitted with a relief valve and pressure gauge. As will be clear from the figures, the whole power and compressor unit is enclosed by means of a hinged bonnet. It is claimed that, owing largely to the special valve gear design, this compressor has a volumetric efficiency greater than that of an ordinary compressor of equivalent capacity and running at 400 r.p.m. The petrol consumption is low, the tank capacity of 16 gallons being sufficient for 17 hours' running under full load. The low consumption is stated to be largely owing to the governing system, the engine and compressor being both governed. There is a pneumatic control on the carburettor which enables the engine to tick over immediately the air reaches a predetermined pressure in the receiver, and at the same time lifts the suction valves of the compressor from their seats. An impulse starter is fitted to the magneto, ensuring easy starting without swinging the engine, while the controls are arranged on a control board, and the set can be started and run without opening the bonnet. The truck wheels are removable, to allow the set to sit on its runners without fouling the axles or any part of the machinery. The set is termed the "Broomaster" by its makers, Messrs. Broom and Wade.

MOTOR GENERATOR SETS FOR SYDNEY.—The office of H.M. Trade Commissioner at Sydney reports that the Postmaster-General's Department, Sydney, are calling for tenders to be presented by September 15, for motor generator sets. A copy of the specification and blue prints can be inspected by British firms at the Department of Overseas Trade (Room 52), 35, Old Queen-street, London, S.W.1.

SWITCHGEAR AT THE BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY MESSRS. SWITCHGEAR AND COWANS, LIMITED, ENGINEERS, MANCHESTER.

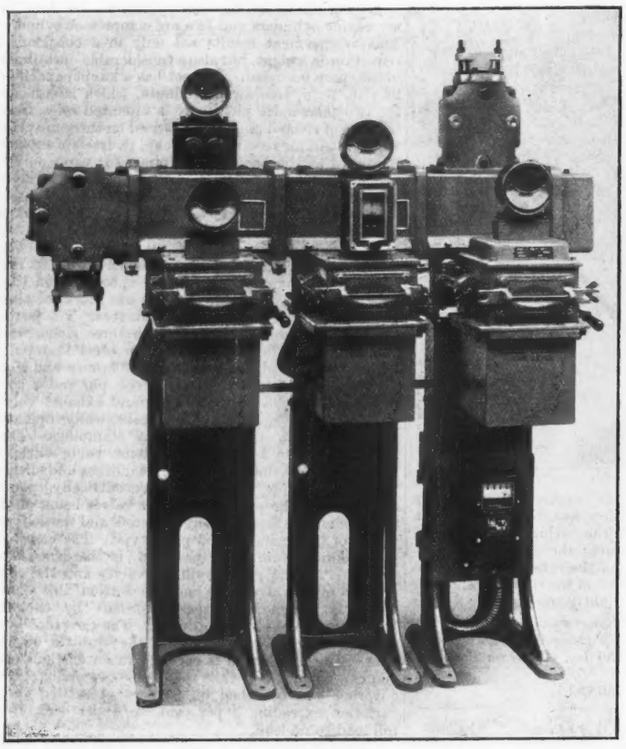


Fig. 1. Ironclad Oil-Immersed Switchgear.

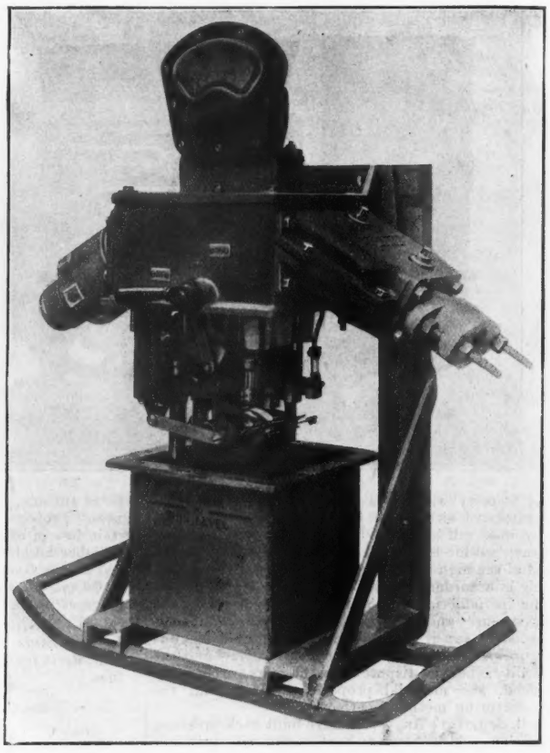


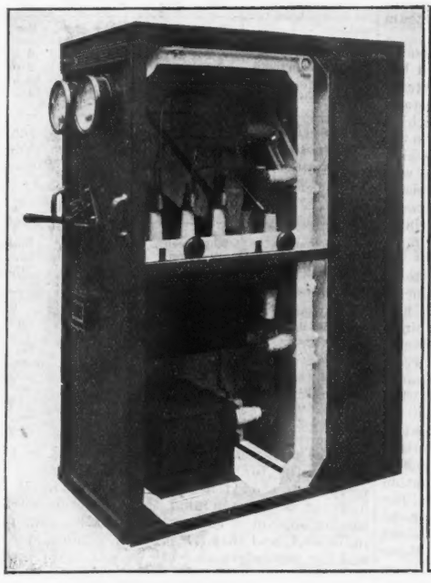
Fig. 2. Gate End Switch.

SWITCHGEAR AND INDUCTION REGULATORS.

The increasing use of high voltages in the electrical industry renders the provision of satisfactory switchgear of the utmost importance. The realisation of this necessity is clearly demonstrated at the British Empire Exhibition, where a large variety of types are on view. Typical examples are shown by Messrs. Switchgear and Cowans, Limited, of Old Trafford, Manchester. One of the exhibits is illustrated in Fig. 1, which shows a three-panel board for pressures up to 3,300 volts and line currents up to 60 amperes. The board is made up of three ironclad units, while extension end caps are fitted to permit of the ready addition of extra circuits. Fitted with a complete system of interlocks and draw-out isolating plugs with oil immersed switches, the design is suitable for use in collieries as well as above ground. Each switch is provided with three series wound over-load coils and transformer-operated ammeter, all actuating coils, trip mechanism, and meter transformers being contained within the oil tank preventing derangement by dirt, mechanical damage, or interference. A supplementary sealing gland is supplied with all cable boxes by which it is possible to seal up a bitumen cable below the point where the cores are splayed out to fill up any cracks in the bitumen insulation. One panel is fitted with a core balance transformer and relay designed to trip the switch when on three-phase load the leakage current to earth exceeds 5 per cent. of the normal. A watt-hour meter carried on a swinging panel is also fitted.

The example shown in Fig. 2 is one of the firm's oil-immersed gate-end switches fitted with time-limit over-load protection, the oil tank being lowered to show the internal parts. The device is strongly made, steel skids serving to facilitate movement. The switchgear comprises an automatic oil-immersed circuit-breaker having three poles each with two breaks, while three overload trip coils enable all fuses to be dispensed with.

All coils and tripping mechanism are completely immersed in oil, the break actually taking place under a good head of oil. The switch is intended to work in conjunction with the Williams-Rowley system of earth protection, which ensures adequate earth continuity up to the coal-cutter or other machine. All pressure on the motor and trailing cable is cut off in the event of the earthing becoming inefficient, the cable being damaged or attempts made to withdraw the pommels from either coal-cutter or gate switch. An ammeter registering up to 100 units is fitted on top of the switch.



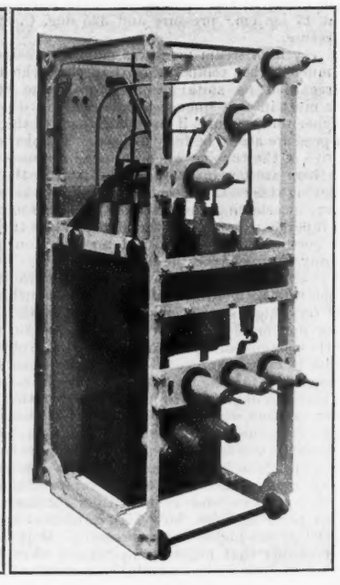


Fig. 3. Truck Type Switchgear: Side View. Fig. 4. Rear View of Truck.

The draw-out truck type switchgear, shown in Figs. 3 and 4, is designed for three-phase working and is fitted with isolating plugs of the spring self-aligning type, oil switch, transformers, voltmeter and ammeter. By means of a cam operated by the switch lever mounted on the front panel rapid action of the switch blades in both closing and opening is assured. The framework is made up of iron sections and two sets of wheels are provided, one bottom set for transporting the truck when removed from the casing, and the other set to engage with the horizontal bars of the casing to assist sliding into place. An automatic shutter to screen off the live parts is provided, and interlocks are fitted. A potential transformer is carried at the bottom of the framework, and is provided with spring-type fuses. Time-limit fuses are fitted

INDUCTION REGULATORS; EMPIRE EXHIBITION.

CONSTRUCTED BY MESSRS. SWITCHGEAR AND COWANS, LIMITED, ENGINEERS, MANCHESTER.

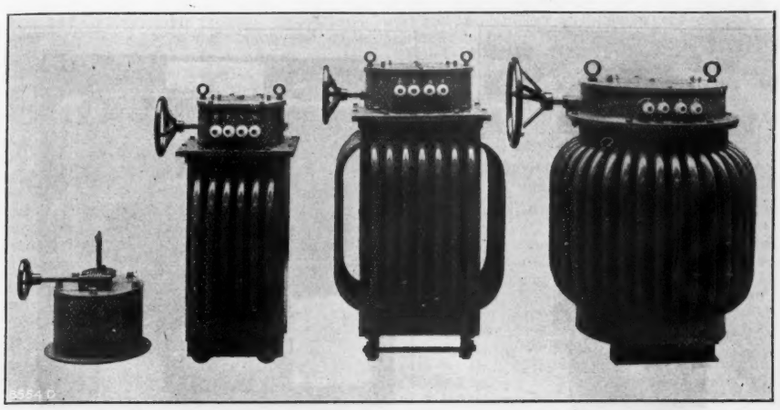


FIG. 5. INDUCTION REGULATORS.

to the oil switch. The voltmeter and ammeter read to 11,000 volts and 300 amperes respectively.

Modern electric distribution from large unit generators through a number of feeders necessitates some form of control for these latter. Such an instrument is provided in the induction regulators shown in Fig. 5, which are equally serviceable for testing apparatus in mines. They are single-phase variable-ratio transformers, suitable for use in all cases which require a variable pressure, applicable gradually. For use in testing extra high gear the regulators are usually employed on the primary side of a step-up transformer by which means the test pressure can be applied from zero to the maximum at a constant rate of increase with a straight line characteristic. They may be operated either by immediate or remote control, by hand or motor automatic gear, and permit of pressure regulation to within 1 per cent when the rotor or movable core is adjusted by a relay-controlled motor. In each model the same principle prevails throughout, a worm, operated by the hand-wheel shown in the figures, actuating a horizontal worm wheel which controls the position of the internal coil on the vertical shaft, clearly visible in the first model. The machines of smaller capacities are air cooled, while the others are oil cooled. The primary and secondary windings are separate, the former rotating with its core. In the larger types the oil tanks are provided with circulating pipes. The electrical efficiency is very high in all cases. The possibility of a sudden rise of pressure at any point is eliminated, since the rise or fall of pressure, exactly in proportion to the movement of the rotor, can only take place gradually. The larger sizes in our illustration show the plug holes, primary connections to the left, and secondaries to the right. For three-phase working, three regulators may be connected up with switchgear and control board exactly as in cable-testing plant. Tests by the Manchester Corporation on the wave form of the 240 volts supply of 50 periods, and on that of secondary pressure of the regulator up to 3,500 volts at 50 periods, revealed very close similarity. In the illustration capacities are 2½, 10, 25 and 50 kv.-a. respectively. Modified designs include a 10-kv.-a. regulator with flame-proof oil tank and packed cable glands, for colliery work, and a combination unit for pressure and current testing especially suitable for trailing cables.

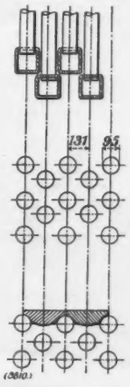
STANDARD STEELS FOR AUTOMOBILES.—The following publications on automobile steels have recently been published by the British Engineering Standards Association:—No. 5005-1924, Wrought Steels; No. 5006-1924, Cold Worked Steel Bars and Strip; No. 5008-1924, Valve Steels; No. 5009-1924, Steel Tubes. The specifications cover the chemical composition, heat treatment, mechanical properties and margins of manufacture of sixteen wrought steels, seven cold worked steels, four valve steels, and four classes of steel tubes commonly used in the automobile industry. Each publication also contains a series of general clauses relating to heat treatment definitions, method of carrying out the mechanical tests, preparation of test samples, and particulars of the standard tensile, bend and notched bar impact test pieces. A similar publication on sheet steels for automobiles (No. 5007-1924) has just been completed and will be published within the next few weeks. Copies of these publications may be obtained from the B.E.S.A. Publication Dept., 28, Victoria-street, London, S.W.1. price 1s. 2d. each post free.

HIGH-PRESSURE WATER TUBE BOILERS.*

O. A. WIBERG, Pinspong, Sweden.

THE demand for high economy in steam-generating plants has been a very predominant feature of the industrial development during the last two decades. This tendency leads to the utilisation of still higher steam temperatures and pressures. Experience shows that the same durability and factor of safety as commonly used can be easily obtained also in the case of high-pressure boilers without going to impractical dimensions.

As regards the elasticity of boilers with straight tubes the sectionalised water tube boiler has appreciable advantages. In comparison with other boiler types this boiler retains a predominating position owing to its safety, facility of standardising, transporting, etc.



It cannot be denied, however, that the sectional boiler, in comparison with other well-known types, suffers from a serious defect, viz., the restrained circulation, as the tube area between the headers and the main steam and water drum is very narrow. As it is hardly possible to arrange more than one return tube for the sinking water column between the main drum and the header, the area of this tube will be inversely proportional to the number of tubes in the section. This arrangement means a very small water connection in case the number of boiler tubes per section is comparatively large.

In addition, it may be mentioned that the headers themselves of many boiler types tend to restrain the water circulation on account of their form. In order to get the tubes in the characteristic staggered position the headers are usually given a sinuous curvature so that each tube end requires a very sharp bend in the header. In the design of a new sectional type high pressure boiler of Swedish manufacture described below, due attention seems to have been paid to these points of view. In this the headers are applied in two separate rows in a staggered position. By this means the sections can be kept closer; the distance between the sections can be considerably diminished, so that the number of sections and also the number of connections for the water circulation will be increased for a certain width of the boiler. Owing to this arrangement the area of the connections between the boiler drum and the sections will be 40 per cent. to 50 per cent. more ample than in a corresponding sectional boiler of the usual type, provided that the tube diameter and the floor space required are the same in both cases.

The double-row headers also allow for a staggered spacing of the boiler tubes, the mutual position of which is selected so as to afford a constant velocity of the gases as far as possible. This velocity has been determined to obtain the highest possible heat transmission and a comparatively low loss in head of draught. As the distance between the tube rows is decreased the tubes could easily be so arranged that the gases come into contact with practically the whole circumference of the tubes. This will be clearly seen from the cross section in the accompanying figure. The area of the circulating tubes being increased, and thus the resistance decreased, it follows that the circulation will be more free and rapid, and consequently the evaporative capacity and efficiency of the boiler will be increased. The risk of local overheating also will be minimised. The boiler is in all other respects identical with other well-known makes of steam generators. This boiler is built in all usual sizes and for pressures up to 800 lb. per square inch.

A boiler designed for 600 lb. per square inch and 750 deg. F. temperature has been in use in the STAL-Company's works since 1920. The following is an extract from report on tests made with this boiler on November 13 and 14, 1923. The tests were carried out by the Swedish Boiler Owners' Association (*Mellersta och Norra Sveriges Angpanneförening*).

Heating surface of the boiler	154	m²
,, ,, ,, superheater	70	m²
,, ,, ,, economiser	89	m²

There is also provided an air-preheater for combustion air. Grate: automatic Dano-stoker.

Test I.—Before this test the boiler was swept, and the furnace was cleaned of ashes and slag before it was fired up. The boiler was under fire for about 4½ hours before the test, during the last hour of this time at the same load as when testing.

Test II.—Commenced 46 minutes after the first test had been terminated and without any previous cleaning or sweeping.

Test III was commenced 6 hours after firing up. The furnaces were cleaned from slag before firing up, but no sweeping had taken place.

Results of Tests.

	I.	II.	III.
Number of test			
Duration of test, hours ..	6·02	2·11	4·5
Coals, effective calorific value ..	7130	7,080	7,080 cal.
Steam pressure (abs.)	20·25	21·3	38·6 kg/cm.²
Temperature of superheated steam	349	367	390 deg. C.
Kg. steam per hour and m² boiler surface	30·45	49·3	28·73
Kg. steam per m² boiler heating surface (reduced 0—100 deg.)	35·5	58·2	33·2
Temperature of water at economiser inlet	5·1	4·7	4·8 deg. C.
Do. at economiser outlet ..	67·5	60·7	72·3 ,,
Temperature of flue gases at boiler outlet	253	292	313 ,,
Do. at economiser outlet ..	132	157	181 ,,
Air temperature at air-heater inlet	40	40	47 ,,
Do. at air-heater outlet ..	70	75	86 ,,
Efficiency of boiler, including superheater	78·9%	79%	77·1%
Do. including economiser ..	86·1%	85·3%	84·6%
Do. including air heater ..	87·5%	86·8%	86·6%

During Test II the boiler was overloaded so that the rate of evaporation reached 58·2 kg./m², though the boiler had been running for 11 hours without cleaning grate or tubes. A considerably greater evaporation would certainly have been reached if time had permitted soot blowing and cleaning of grate before the start.

* Paper, abridged, contributed to Section D of the World Power Conference on July 4, 1924.

ROYAL METEOROLOGICAL SOCIETY.

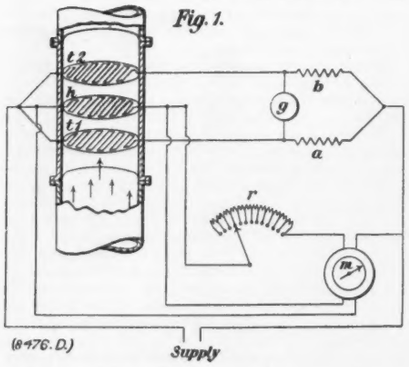
A SUMMER meeting of this society was held at the Rothamsted Experimental Station, Harpenden, on Friday, July 18. In the course of the meeting the following papers were read:—

1. "*Adaption of Variety to Climate*," by Mr. R. A. Fisher, M.A. This paper stated that one of the main problems attacked by the statistical laboratory at Rothamsted in recent years has been to ascertain numerically the effect of weather on the yield of farm crops. The Rothamsted data give the yield of wheat on thirteen plots which have been under uniform manurial treatment since 1851, and the rain records from a large gauge set up in 1853. From these series of values it has been possible to evaluate the actual gain or loss of each consequent upon an additional inch of rain at any time during the harvest year. A comparison of the

THE THOMAS GAS METER AT THE BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY THE CAMBRIDGE INSTRUMENT COMPANY, LIMITED, LONDON.

Fig. 1.



different response of the different plots to rainfall shows the possibility of the farmer adapting his manurial treatment to season and to climate, especially in relation to nitrogenous fertilisers. The work has involved a detailed analysis of the distribution of rainfall through the year for each year since 1853, some of the results of which are of interest. The total rainfall fluctuates greatly from year to year, but there is some evidence that the fluctuations are not at haphazard, but that at two periods centred about 1879 and 1914 there has been a prolonged spell of significantly increased rainfall. On the other hand, one feature of the rainfall distribution has shown a steady and apparently uniform change throughout the seventy years. This involves increasingly wet Decembers, and perhaps drier weather in spring and autumn. Data on this point from other stations would be of great interest.

2. "*A Comparison of Three Different Types of Radiation Recorder*," by Mr. W. B. Haines, B.Sc. This paper deals with a comparison of the readings taken at Rothamsted with three types of radiation recorder. The first of these is a recorder of the Callendar pattern depending upon the difference in temperature between a black and a bright resistance exposed to the sky. These readings are taken as standard. The second instrument (Wilson integrator) reads the amount of alcohol or other volatile liquid which distills from a bulb exposed to the radiation into a similar shielded bulb. The third set of data is the record of hours of bright sunshine from the widely-used Campbell-Stokes apparatus. Reference is also made to a fourth set of data, that given by an evaporimeter of the porous candle type, since the readings of this instrument are correlated to the amount of radiation. A diagram made by plotting the data to suitably-adjusted units, brings out the following points:—(1) The alcohol integrator gives readings much too low during the winter months. The readings could be correlated for the effect of temperature upon the vapour pressure of alcohol, but there is a large random error which makes it impracticable to advance a correction formula to deduce the true radiation. (2) The hours of bright sunshine should be corrected by a factor depending upon the time of day and year (*i.e.*, upon the sun's altitude). A formula deduced by Angström from the Stockholm data, for calculating total radiation from hours of bright sunshine, is examined and found fairly satisfactory for the Rothamsted data. It is concluded that such a formula, based upon the data at one station, could, with due caution, be adopted for another station. The evaporimeter results follow the hours of sunshine very closely, but some care is needed in the choice of a site for this instrument.

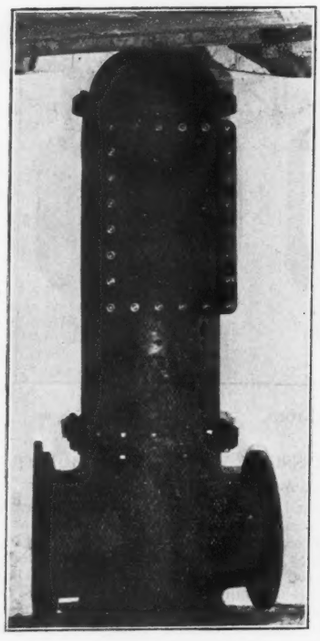


Fig. 2. General View.

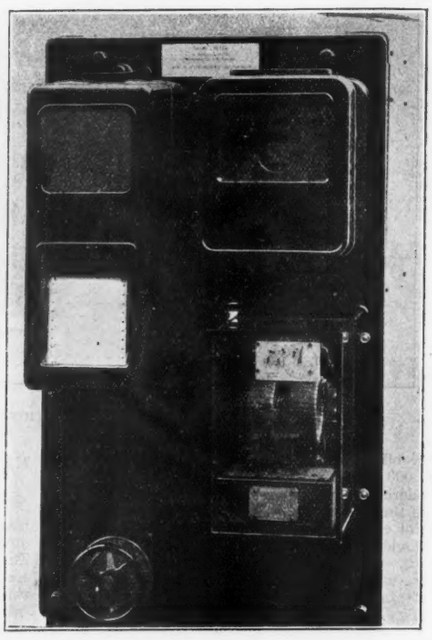


Fig. 3. Switchboard Panel.

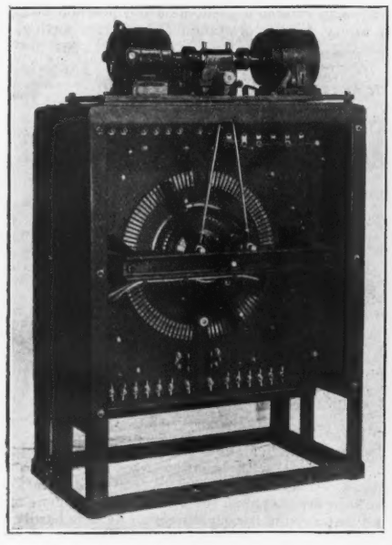


Fig. 4. The Regulator; Front View.

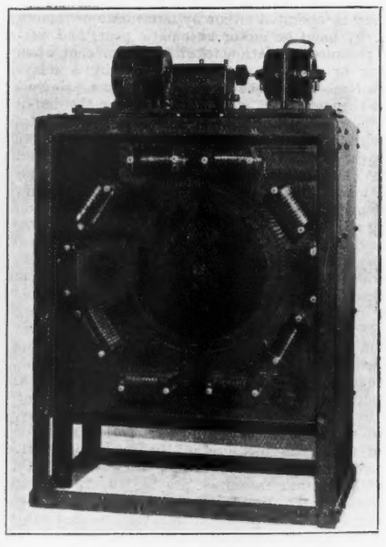


Fig. 5. The Regulator; Back View.

THE THOMAS GAS METER.

Despite the fact that a gas is matter in the simplest state, considerable difficulty has usually attended accurate measurement outside the laboratory. This is mainly due to the necessity for reducing results to some standard temperature and pressure, by calculation, from the data recorded by the various instruments usually used. This added work, however, is not required when the Thomas gas meter, shown in Figs. 1 and 2, above, is used to measure quantities of gas passing through it, since such quantities are automatically recorded directly in terms of cubic feet at standard pressure of 30 in. of mercury and saturated temperature of 60 deg. F. The fundamental principle of the instrument is based on the fact, demonstrated by experiment, that the specific heat for all gases occurring in practice is very nearly constant. It follows that if a gas flowing through a duct provided with a heater is raised in temperature by a fixed and constant amount, the quantity of heat supplied is a measure of the amount of gas passing. Advantage of this is taken in the design which will be clear from Fig. 1. A heater unit h, constructed of transversely placed resistance wires is connected through a rheostat and a wattmeter to a source of current supply. In front and behind of this heater are placed resistance thermometers, t_1 and t_2, which form the two arms on one side of a Wheatstone's Bridge, the coils a and b making up the other side. The galvanometer g serves to indicate when there is a balance, which condition exists when there is exactly 2 deg. F. temperature difference between the gas at inlet and outlet, attainable by suitably adjusting resistances a and b. The question of water vapour present in the gas to be measured requires consideration. If some form of compensation were not possible the meter would read incorrectly when the temperature of the approaching gas changed from normal conditions. For example assume we have 1,000 cub. ft. of gas saturated at normal temperature and pressure. If this is heated through 2 deg. F., the normal range of the instrument, a certain amount of wattage will be consumed. The wattmeter is calibrated to record that this amount of wattage represents 1,000 cub. ft. of gas, and since the specific heat of gas and its water vapour at 60 deg. F. is constant, changes in the temperature and pressure do not change the heat energy required to raise the mixture 2 deg. F., nor do they change the reading of the wattmeter. Should the gas be taken at a higher temperature, however, and be saturated at that temperature, it will contain more than the normal quantity of water vapour, and additional energy will be required to heat up this water vapour through the range of 2 deg. F., which, unless compensated for, would be read as an additional volume of gas passed. To correct for this the temperature, and consequently the heat energy introduced,

must be diminished in the same proportion as the wattage, required to heat the gas with the normal amount of moisture, is increased. This is accomplished in the instrument automatically by the nickel and manganese thermometers upsetting the bridge balance when too much water vapour is carried in the gas. The galvanometer needle then deflects to one side or the other, engaging with a connection to the motor-driven regulator shown in Figs. 4 and 5, which it controls. The necessary adjustment of the heater then takes place.

A great advantage of the meter is that continuous records may be inspected at any convenient point, though at a considerable distance from the plant. The graphic instruments for the purpose, together with the galvanometer for the temperature control system, are mounted on a panel, as shown in Fig. 3, which entirely controls the whole arrangement. The meter is designed to standard pipe specifications and has a capacity of 300,000 cub. ft. of gas per hour. The apparatus is constructed by the Cambridge Instrument Company, Limited, 45, Grosvenor-place, London.

HISTORICAL NOTE ON THE KAPLAN TURBINE.*

By Dr. J. KNEIDL.

THE following paper refers to a new type of water turbine suitable for medium and low heads. The Kaplan, or rather the Storek-Kaplan turbine, which was originated and constructed in the territory of Czechoslovakia, has movable runner blades and the advantages gained by its use are, that, compared with the Francis turbine usually employed under similar conditions, a much higher relative speed can be attained, and an efficiency achieved which remains practically constant under varying discharges and heads of water.

Much work had to be done before these advantages were obtained. During 1908-1911 Professors Kaplan, Mieses and Hamel, all of the German Technical University of Brno, elaborated the theories of multi-dimensional flow. Later, Professor Kaplan, anxious to put those theories to practical test, asked Mr. Storek to supply him with a testing station at the Technical University. After experimenting on a small scale, Kaplan intended to elaborate his ideas on a large installation.

Mr. Storek gave the necessary facilities and supplied a small turbine having a runner of 100 mm. diameter with which Kaplan made his experiments by the aid of glass suction pipes, &c.

The outcome of those investigations was the Kaplan turbine which has been patented in all the principal countries.

In 1918, Mr. Storek, having acquired the rights of manufacture, constructed the first turbine having movable runner blades, for Hofbauer Witeve, Velm, Austria, the tests on which were carried out by Professor Budau, of Vienna, in 1919.† The dimensions of this machine were as follows :—

Diameter of runner	600 mm.
Power	35 b.h.p.
Head	3 metres.
Discharge	1,100 litres per second.
Speed	480 r.p.m.
Specific speed	700-800.

*Paper contributed to Section B of the World Power Conference on July 4, 1924.

† The results of the braking tests of this turbine are published in *Die Wasserkraft*, 1919, No. 17.

More machines followed and in the construction of these with higher specific speed many difficulties had to be overcome.

The Czechoslovakian Government taking an interest in the new type of turbine had a machine made for trial and the Ministry of Public Works selected a site originally built for the reception of a Francis turbine at Podebrady on the Elbe.

The dimensions were as follows :—

Diameter of runner	1,800 mm.
Power	275 max. b.h.p.
Head maximum	2·5 metres, min. 1·5 m.
Discharge maximum	10 cu. metres per second.

In Fig. 1 are shown the results of the tests at Podebrady.*

In 1921 the representatives of a German firm made certain tests in Storek's testing station on experimental turbines having a diameter of 300 mm. By comparing the test curves of Velm, Podebrady, and laboratory tests of turbines equipped with similar runners, it can be seen that the Kaplan turbine conforms with the law of development of Professor Camerer.†

In order to investigate the cavitation produced by high-speed runners a Kaplan turbine was mounted for trial at the power plant of Mr. F. Schmitt, of Iserthal, in a setting having window panes in the suction pipe.

The wonderful results obtained at Podebrady and at Iserthal led to the installation of other plants. At Gorizia two Kaplan turbines were erected for the Colonoficio Irieslina Brunn, S.A., each having the following dimensions :—

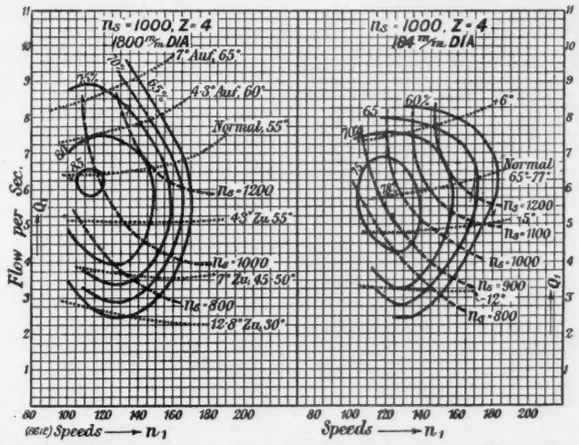
Diameter of runner	1,800 mm.
Power	1,000 b.h.p.
Head	5 metres.
Discharge	20·5 cub. m per second.
Speed	315 r.p.m.

In the power house of Kromertz on the March, turbines of the following sizes were erected :—

Diameter of runners	2,200 mm.
Power	1,000 b.h.p.
Head	4·4 metres.
Discharge	23 cub. metres per second.
Speed	214 r.p.m.
Specific speed	1,100.

Official tests have not yet been made and private tests cannot be published. The efficiency curve, however, will resemble that of Podebrady.

The above information will, it is hoped, be sufficient to show that in Czechoslovakia a pioneer movement of great importance to water-power development has been initiated.



CURVE OF BRAKING TEST AT PODEBRADY. COMPARISON WITH THE KROMERTZ RUNNER OF 184 MM. DIAMETER, NS. = 1,000-1,100.

ALL-BRITISH WIRELESS EXHIBITION, 1924.—The second great Exhibition, devoted exclusively to the development of wireless, and organised by the National Association of Radio Manufacturers, will this year be held at the Albert Hall, Kensington, from September 27 to October 8, inclusive.

* See Professor Dr. Hybl in *Zpravy verejne sluzby technicke*, vol. 4, No. 4, and a German translation of this treatise in *Die Wasserkraft*, 1922, Nos. 12 and 13. See *Strojnicky Obzor*, 1923, Nos. 2, 4, 5. Ing. Josef Linsbauer skusebni turbina Storek-Kaplanova v Podebradech.

† See Dr. Camerer, Vorlesung uber Wasserkraftmaschinen, p. 415-416.

CATALOGUES.

Crank-shafts.—Mr. J. Hamilton Gibson, 3, Central-buildings, Westminster, London, S.W., has issued a booklet describing the "Unity" built-up crankshaft which is suitable for heavy work.

Blow-pipes.—Blow-pipes for glass working, with single or multiple jets, are dealt with in a catalogue issued by Messrs James Keith and Blackman Company, Limited, 27, Farringdon-avenue, London, E.C. 4.

Electrical Machinery.—The English Electric Company, Limited, Kingsway, London, W.C., have sent us illustrated reprints of articles on a 15,000 h.p. water turbine for the Tata Hydro-electric Supply Company, and a three-high plate mill for the Clydebridge Works of Messrs. David Colville and Sons, Limited.

Gear-Tooth Calipers.—Messrs. David Brown and Sons (Hudd.), Limited, have issued a card illustrating their gear-tooth vernier caliper and fixed-jaw gear tooth caliper. An illustration of a worm broken to show the depth and uniformity of the case-hardening obtained with the carburiser manufactured by the firm has also come to hand.

Electrical Machinery.—Messrs. Brown, Boveri and Co., Limited, Switzerland, and Trafalgar House, Waterloo-place, London, S.W., have sent us a copy of a recent issue of their House Journal, containing descriptions of their electric motors for driving ring-spinning frames and hoisting winches, and also including a number of articles of a practical character.

Electrical Machinery.—A catalogue describing the Morkfos-Solbergfos Power Station, Norway, and an automatic regulator for generators, and another catalogue dealing with electrically-driven blowers and braking devices for the lowering motion of electric lifting plant, are to hand from Messrs. Oerlikon, Limited, Switzerland, and 34, Norfolk-street, Strand, London, W.C.

Scaling Tool.—Messrs. F. Gilman (B.S.T.) Limited, Grange-road, Smethwick, Birmingham, have sent us a catalogue of the "Skatoskalo" electrically-driven appliance made by them for removing scale from boilers and boiler tubes. Illustrations are given of all the parts and the various cutters, brushes and other accessories which may be used with the tool, including grinding and polishing wheels and rotary brushes.

Driving Chains.—New editions of two of their catalogues have been issued by Messrs. Hans Renold, Limited, Didsbury, Manchester. One takes the form of a series of practical notes and tables on the selection of chain gear, and is intended to assist designers in selecting the most suitable chains and wheels for any given drive. The other deals with the application of the chain drive to machine tools and gives a number of successful examples, including grinding machines.

Bookbinding Machines.—We have received leaf catalogues of two stitching machines from Messrs. R. Hurner, Limited, 121, Rosebery-avenue, London, E.C.1, who are agents for Messrs. Brehmers, the makers. One machine is for wire stitching books, magazines, &c., up to ¾ in. thick, and the other is for stitching and knotting with thread or cord, or inserting and knotting a loop for suspension. The catalogue states that 8,400 of the first-mentioned machine have been sold.

Electric Motors for Rolling Mills.—A long list of installations of electrically-driven rolling mills carried out by the Metropolitan-Vickers Electrical Company, Limited, Trafford-park, Manchester, has been received. The list contains a dozen illustrations of motors and mills, including a motor of 16,000 horse-power driving a 42-inch reversing mill. In recent years the firm has supplied motors developing 150,000 horse-power under normal working conditions and 300,000 horse-power on peak loads.

Gear-Tooth Grinding.—A catalogue dealing specially with the grinding of toothed gears for electric traction work is to hand from the Gear Grinding Company, Limited, Handsworth, Birmingham. The specification of the company covers maximum errors of the following order: back lash, 0·007 in.; parallelism, 0·001 in. in 5 in.; tooth to tooth index, 0·0005 in.; eccentricity, 0·005 in. on 30 in. diameter, and 0·002 in. on 12 in. diameter. The advantages of grinding, which is carried out after hardening by a wheel formed to the tooth space, are fully discussed.

Guns.—A catalogue of guns from Messrs. William Beardmore and Co., Limited, Glasgow, contains illustrations and some descriptive text of 4 in. and 6 in. naval guns, 40 mm. and 57 mm. light field guns, an 18-pounder field gun, 6 in. and 9·2 in. howitzers, and an anti-aircraft mounting for two 4-in. guns. Some particulars of machine guns of rifle calibre and views of the largest naval guns in the machine shop are also included. The mechanisms and methods of transporting and training the guns are of considerable mechanical interest, and the catalogue is well printed and illustrated.

Brass Work.—A new catalogue of 140 quarto pages, issued by Messrs. Hattersley (Ormskirk), Limited, Ormskirk, Lancashire, who have acquired the business of the United Brassfounders and Engineers, Limited, forms an excellent example of British engineering trade literature. The various sections deal with gun-metal valves, heating fittings, cocks, boiler mountings, injectors and ejectors, fire fittings, water fittings, cast-iron valves, condenser ferrules and brass nuts, and, finally, with brass and bronze and other alloys in rods, extruded sections and ingots. Practically all pipe fittings, instruments and accessories are included in a full range of sizes, of which clear specifications and tables of prices and dimensions are given. The catalogue will be particularly useful as a reference book.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS OF 1907 AND 1919.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the communicators are given in italics.

Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 1s.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

GAS ENGINES, PRODUCERS, HOLDERS, &c.

212,072. J. Davidson, Tutbury, Burton-on-Trent. Internal Combustion Engines. (3 *Figs.*) February 14, 1923.—The invention relates to internal combustion engines wherein a plurality of working pistons is connected to a pump piston which reciprocates with the working pistons. According to the invention, there is provided between the pump piston and each working piston a floating connection which allows each working piston to move laterally relatively to the pump piston, whereby the working pistons and pump pistons can move relatively to one another into the positions best suited to the working conditions. 1, 1 are the working pistons sliding in the working cylinders 2, 2 which are in open communication at both ends. 3 is the pump piston sliding in the pump cylinder 4. Each working piston 1 rests with one end on the end of the pump piston 3. The working pistons 1, 1 are hollow and are each provided at that end which

Fig. 1.

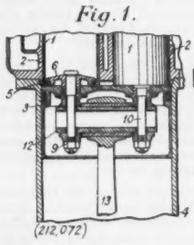
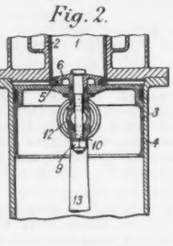


Fig. 2.



rests on the pump piston 3 with an inwardly directed radial annular flange 5. Each working piston 1 is connected to the pump piston 3 by means of a member 6 with an undercut edge. The member 6 is secured to the pump piston 3 by means of a nut 9 and a screw bolt 10 passing through the member 6 and through the end of the pump piston 3 and the bolt 10 bearing with its head against the member 6. The screw bolts 10 are also employed to secure a tubular pin 12 to the pump piston 3 for the piston rod 13 to oscillate on. When the parts are assembled, the lip on the member 6 engages the annular flange 5 on the working piston 1 and thereby connects the working piston 1, 1 with the pump piston 3. The member 6 is of such size and the extent of the undercut is such that the working piston 1 is free to slide laterally in any direction on the pump piston 3 against the friction set up between the lip on the member 6 and the annular flange 5. (*Sealed.*)

MOTOR ROAD VEHICLES.

212,141. Bentley Motors, Limited, London, and F. T. Burgess, London. Brakes. (2 *Figs.*) April 14, 1923.—The invention relates to brakes for use on motor vehicles, and it has for its object to provide a very substantial pivotal attachment of the brake shoes upon the anchor plate. According to the invention, the plate is formed with a radial web which is spaced slightly from the wall of the plate, and the anchor pin for the shoes is mounted in this web, projecting at both sides thereof. The anchor plate A is dished and is formed with a large central hole, around which it is faced for attachment to

Fig. 1.

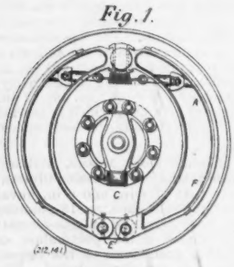
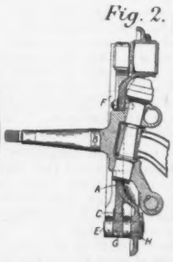
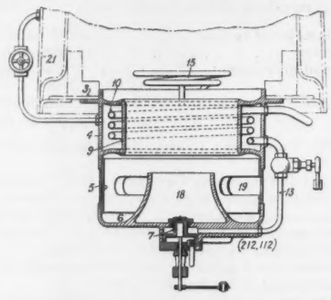


Fig. 2.



a flange on the axle B. The plate A is dished so that the edges lie considerably to one side of the plane of attachment, and at the bottom the plate has formed integral with it a depending web C, which lies in the plane of the centre of the plate. This web is spaced slightly from the rim of the plate, and it is formed with bosses G to receive the anchor pins E for the shoes F. The pins may also enter bosses H in the dished edge of the plate A and be fixed there by a split pin. The shoes F are forked at their pivotal ends, and these forked parts pass one each side of the web C and are held in place by the anchor pins E. (*Sealed.*)

212,112. Deighton's Patent Flue and Tube Company, Limited, Hunslet, Leeds, C. A. Millington, Hunslet, Leeds, and W. J. Lewin, Hunslet, Leeds. Motor Wagon Oil-Fuel Furnace. (2 *Figs.*) March 9, 1923.—The invention has for its object the provision of a new or improved oil-fuel furnace for the boilers of steam motor wagons. According to the invention, the base plate 3 of the boiler is fitted with a depending stationary casing 4 provided with a depending wall 5, which carries at its base a stationary pan 6, whose base plate is provided with a burner 7. The casing 4 is formed around its inner wall with a water-jacket 9 fitted with a pipe-coil 10 coupled to the burner 7 by a pipe 13. Within the firebox 1 is a pipe-coil 15, whose one end is connected to the upper part of the casing 4, while its other end is coupled to the burner 7. The burner 7 is surrounded by an upstanding funnel 18 and in the annular space between the funnel 18 and the vertical wall 5 of the pan 6 cotton waste soaked in paraffin is inserted, while air ducts 19 formed in the vertical wall 5 adjacent to the inserted waste are made adjustable through the medium of an encircling hit-and-miss damper. The jacket 9 is coupled to the water space 21 and the steam space of the boiler



(not shown). In order to get up steam, the paraffin soaked waste is lighted, when the water within the jacket 9 becomes heated to boiling point, the steam therefrom passing into the pipe-coil 15, where it becomes superheated and from thence it passes to the burner 7, while the heated water within the jacket 9 simultaneously heats up the oil passing through the pipe-coil 10. In this way, superheated steam and heated oil become fed to the burner 7 in a very short space of time and ensure the quick generation of steam in the boiler, the continuity of which is effected by the burner 7 in the ordinary way by passing steam from the boiler to the jacket 9. (*Sealed.*)

212,066. Roadless Traction, Limited, Hounslow, and O. S. Penn, Wandsworth Common, London. Endless Track Vehicles. (20 *Figs.*) February 9, 1923.—The invention relates to endless track vehicles. According to the invention, bogie frames having two or more rollers are employed, the rollers either being arranged in pairs or tandem. The bogie frames, according to the invention, are mounted so as to allow of movements about transverse horizontal and vertical axes or about transverse horizontal, vertical, and longitudinal horizontal axes to allow of universal movement. 10 is a bogie frame supported on rollers 11, which carry the weight of the vehicle and run on a track 12. The track 12 is carried on sprocket wheels 13, 14, the sprocket wheel 13 being driven and mounted on the chassis

Fig. 1.

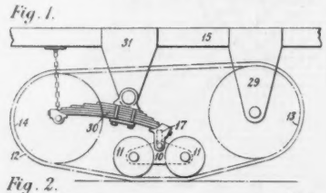
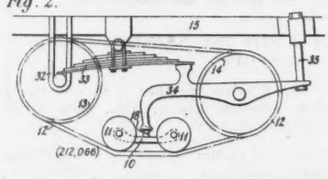


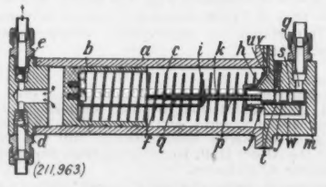
Fig. 2.



15. 14 is an idler sprocket wheel. In Fig. 1 the sprocket wheel 13 turns on an axis in a bracket 29 rigidly fixed to the chassis 15, whilst the idler 14 is mounted at the end of a laminated spring 30 on whose other end is the bogie frame 10 pivoted on a vertical point 17. The spring 30 is pivotably mounted on a bracket 31 fixed to chassis 15. In Fig. 2 the axis of the sprocket wheel 13 is slidably held in bearings 32 by a laminated spring 33 fixed to the chassis 15. The spring 33 also engages with a lever 34 on whose downwardly turned end is a spherical bearing engaging with a sphere 18 on the bogie frame 10. To the other end of the lever is rotably mounted the idler 14, the extreme end of the lever 34 embracing a guide 35 fixed to the chassis 15. (*Sealed.*)

PUMPS.

211,963. K. A. B. Gilfillan, London. Raising of Liquids. (1 *Fig.*) November 30, 1922.—The invention relates to apparatus for raising liquids in which use is made of a convenient source of pressure or suction and in such apparatus, according to the invention, a mechanically-operated piston valve has a valve rod around which are coiled two springs, between the adjacent ends of which the end of the piston rod is slidable relatively to the valve rod, the piston valve being retained in its alternative

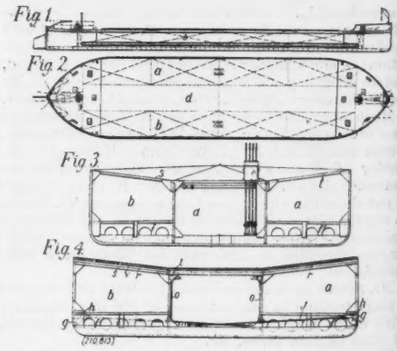


positions by the co-action of a spring-loaded ball with peripheral grooves in the piston valve. The device is constituted by a cylinder *a* and a piston *b* caused always to tend to move towards one end thereof by a helical spring *c* situated between the piston and the opposite end (hereinafter termed the engine end) of the cylinder *a*. That end of the cylinder *a* towards which the piston *b* tends to move (hereinafter termed petrol end) is in communication with a petrol tank through a non-return valve *d* permitting only the entry of petrol to the petrol end of the cylinder *a* and with a carburettor through another non-return valve *e* permitting only the passage of petrol from the cylinder *a* to the carburettor. The piston *b* has a short piston-rod *f* projecting towards the engine end of the cylinder *a* in which are two ports *g* and *h* communicating respectively with the induction pipe (not shown) and with the ambient atmosphere. The ports *g* and *h* are controlled by a piston valve *j* through a piston-valve-rod *k* by the movements of the piston *b*. The piston valve *j* is slidably mounted in a valve chamber *m* into the opposite ends of which lead the ports *g* and *h*, and the free end of the piston rod *f* is bent at right angles to its length as at *i* and bifurcated so as slidably to embrace the piston-valve rod *k*, between two washers also slidable thereon, against which washers abut the adjacent ends of two springs *p*, *q*, the other ends of the springs abutting respectively against the piston-valve *j* and against a nut adjustably screwed on the piston-valve-rod *k*. The piston-valve *j* is formed with two peripheral grooves *s*, *t* into which a ball *u* is pressed alternately by a spring *v*. Leading from the cylinder *a* to that end of the piston-valve-chamber *m* with which the port *g* communicates is another port *w* and the construction is such that when the piston *b* moves, say, towards the petrol end of the cylinder *a* under the influence of the helical spring *c* the piston-rod *f* slides on the piston-valve-rod *k* until the spring *q* is compressed to such an extent as to overcome the opposition due to the engagement with the groove *t* of the ball *u* under the action of its spring *v*, whereupon the piston-valve *j* is moved rapidly towards the petrol end of the cylinder *a* until the groove *s* is engaged by the ball *u*, thus closing the port *h* and placing the port *g* in communication with the cylinder *a* through the piston-valve-chamber *m* and the port *w* just before the end of the stroke of the piston *b*. The suction in the induction pipe of the engine thereupon evacuates the engine end of the cylinder *a*, thus causing the piston *b* to travel back against the action of the helical spring *c* towards the engine end of the cylinder *a*, and to draw up petrol into the petrol end of the cylinder *a* through the non-return valve *d*, the piston-rod *f* meanwhile sliding on the piston-valve-rod *k* and compressing the spring *p* until just before the end of the stroke of the piston *b*, the opposition due to the engagement with the groove *s* of the ball *u* under the action of its spring *c* is overcome and the piston-valve *j* is moved rapidly to close the induction port *g* and open the atmospheric port *h*. The piston *b* is then free to return towards the petrol end of the cylinder *a* under the influence of the helical spring *c* thus pumping petrol through the other non-return valve *e* to the carburettor. When the piston *b* has reached a pre-determined position, near the end of its stroke, the induction and atmospheric ports *g* and *h* are respectively opened and closed and the cycle of operations is repeated. (*Accepted March* 12, 1924.)

SHIPS AND NAUTICAL APPLIANCES.

210,813. Flannery, Baggallay and Johnson, Limited, London, A. Harker, London, and the Hon. A. McDonnell, Westminster. Barges. (4 *Figs.*) September 7, 1922.—The invention relates to transporting vessels of the kind in which the hull includes tanks adapted to be flooded with water at the same time as air is exhausted therefrom, in order that, for dumping purposes, the vessels may be restrainedly tipped or tilted at a suitable point in their transit so that a deck load, as distinguished from a hopper load, can be discharged. The barge, which has a flat bottom, is provided with two lateral longitudinally arranged top side semi-scuttling tanks *a* and *b* and with a central longitudinally arranged closed hold *d*. The hold *d* is in free communication with lateral air spaces or holds *f* and *f1* formed below the top side tanks *a* and *b*. Each scuttling tank *a* and *b* is provided with a water inlet and outlet pipe *g* that extends through the hull of the barge and is controlled by a sea-cock *h*, and with an air outlet and inlet valve *i* opening into the hold *d*. Each sea-cock *h* is arranged to be opened and closed by a rod *j* actuated by a hand-lever. The air valve *i* for each scuttling compartment is operated by a rotary rod *o* and lever arms from the rod *j* of the corresponding sea-cock *h*. The deck comprises battens *r* laid upon plating *s*, which surmounts the several frames *t* of the hull, tanks *a* and *b* and hold *d*, so that such battens occupy positions coincident with the top member of the frames *t*, longitudinal timbers being in turn secured to the battens. On this deck rubble may be loaded, the amount being determined by the natural angle of repose of such material. In the example shown, the deck has a longitudinally arranged flat horizontal central portion and two flat upwardly and outwardly

Fig 1.

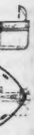


inclined lateral portions. On arrival at a tipping site, a barge constructed as described, and having a deck load of rubble, will be moored over the point at which it is desired to deposit the rubble and the sea-cocks *h* and air valves *i* of the semi-scuttling tank *a* or *b* on that side of the barge towards which it is desired to tip the load will be opened. As the water enters the tank, the barge will commence to list, causing the deck to assume a continually increasing angle to the horizontal until it reaches the angle at which the deck load will slip from the deck and be dumped on the required site. The barge will then right itself to such an extent that the surface of the water in the semi-scuttling tank *a* or *b* used will be above the level of the water outside the barge. The water will consequently commence to flow from the semi-scuttling tank through the sea-cocks and become discharged into the sea, and as the bottom of the tank will be above the flotation level of the barge when light, the tank will ultimately empty itself. A barge such as described, whilst more especially intended for dealing with materials such as are used in harbour constructions, has great advantages over hopper discharging types of lighters in that, by reason of its watertight construction, it can, on completion of the harbour works, be used for general purposes, including the carrying of oil in bulk. When used for carrying oil the barge may be provided with a pipe line or lines communicating with the several compartments of the top side tanks *a* and *b* and with the hold *d* and its lateral extensions *f*, *f1* below the top side tanks. (*Sealed.*)

ader *a* and
permitting
arburettor.
wards the
s *g* and *h*
not shown)
h are con-
k by the
slidably
s of which
d *f* is bent
as slidably
shers also
acent ends
utting res-
adjustably
is formed
is pressed
a to that
rt *g* com-
such that
nd of the
he piston-
g is com-
on due to
the action
d rapidly
roove *s* is
acing the
he piston-
the stroke
he engine
thus caus-
he helical
to draw
the non-
e piston-
efore the
ue to the
action of
d rapidly
c port *h*.
nd of the
pumping
burettor.
don, near
s *g* and *h*
perations

.

Limited,
Donnell,
22.—The
n which
water at
that, for
ipped or
ck load,
ed. The
al longi-
and with
hold *d* is
f and *f*1
ing tank
e *g* that
by a sea-
into the
d closed
for each
nd lever
he deck
unts the
hat such
r of the
to the
t being
dal. In
ged flat
twardly



barge
e, will
rubble
k *a* or
ip the
ge will
nually
gle at
on the
extent
a or *b*
The
ttling
e sea,
level
itself.
d for
tions,
hters
com-
poses,
rying
com-
tanks
below